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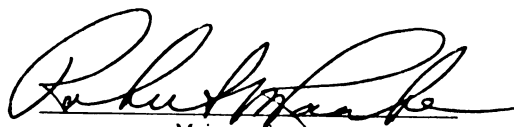
CENTRAL BANK INDEPENDENCE AND MONETARY POLICY EFFECTS

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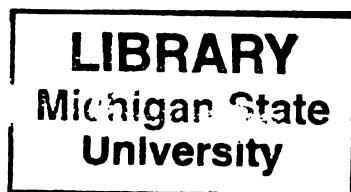
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CENTRAL BANK INDEPENDENCE AND MONETARY POLICY EFFECTS

By

Min Chang

A DISSERTATION

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

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ABSTRACT

CENTRAL BANK INDEPENDENCE AND MONETARY POLICY EFFECTS

By

Min Chang

This dissertation investigates the effects of central bank independence (CBI) on monetary policy effects, especially, liquidity effects. Chapter I offers a survey of previous studies and the ideas of this thesis. Chapter II examines the variable indexes for CBI and investigates the relationship between CBI and inflation in developing countries as well as in developed countries. It is found that there is a significant negative relationship between CBI and inflation in developed countries but not in developing countries. It is argued that the levels of CBI in developing countries are too low to have an impact on the economy.

Chapter III finds an implication for the relationship between CBI and monetary policy effects with the basic liquidity model. Then it applies the traditional econometric approaches to find the empirical results. It is shown that the higher CBI can result in the stronger monetary policy effects. For more correct identification, Chapter IV constructs both non-structural and structural vector autoregression (VAR) models to examine the effects. The non-structural VAR models confirm the positive effects of CBI on the monetary policy effects while the results from the structural VAR models are not significant. Chapter V summarizes the conclusions of this study.

To my mother, parents-in-law,
and
the memory of my father
for his love and support throughout his lifetime.

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CHAPTER I

INTRODUCTION

In recent years many countries have adopted or made progress toward adopting legislative proposals making their central banks more independent. Between 1989 and 1991, New Zealand, Chile, and Canada enacted legislation that increased the independence of their central banks. The 1992 Treaty on European Union, Maastricht Treaty, requires EC members to give their central banks more independence to establish new European central bank (European Monetary Union). As a result, EC countries that do not yet have strong independent central banks have tried to make their central banks more independent¹. Furthermore, the governments of Mexico and Brazil have announced their intentions to introduce legislation to create more independent central banks. More recently, in 1996, the government of Japan also announced the proposal removing the Bank of Japan from government control. In 1997, newly-elected labor party government in U.K enhanced the independence of the Bank of England by giving more autonomy to the bank in monetary policy decision procedure.

The changes in legislation usually give more authority to the central banks and also direct them to focus mainly on the objective of price stability even at the cost of disregarding other objectives such as high employment or economic growth. The success of the highly independent Bundesbank and Swiss National Bank in maintaining

¹ To meet the level of independence described by the Maastricht Treaty, a central bank must be prohibited from taking instructions from the government. The term for central bank governors must be set at a minimum of five years. In addition, the central bank must be prohibited from purchasing debt instrument directly from the government and from providing credit facilities to the government.

comparatively low rates of inflation for prolonged periods of time as well as recent empirical and theoretical studies focused on central bank independence have contributed this tendency.

The theoretical argument stems from the wide acceptance of the analysis of two stylized macroeconomic facts in the papers of Kydland and Prescott (1977) and Barro and Gordon (1983). They argue that the long-run Phillips curve is vertical, that is, inflation has no permanent effect on real outcomes and that governments nonetheless have an incentive to spring inflationary surprises upon the public. As a result, these papers argued, a primary cause of inflation was government's inability in the eyes of the public to commit credibly to a low inflation policy. One could remove the time-inconsistency problem by making government unable to renege upon a commitment to low inflation. In Rogoff (1985), the appointment of a conservative central banker was shown to be one means to achieve low inflation. These theoretical arguments, based upon the assumption that central banks' preferences are more inflation averse than those of government, subsequently stimulated empirical research.

Several empirical studies including Alesina & Summers (1993), Cukierman (1992), Cukierman et. al. (1993) and Fischer (1994) found that greater central bank independence is associated with lower levels of inflation. Those studies conclude that the countries which have low central bank independence have experienced high levels of inflation and high variance of inflation rates because political and economic dependence restrict the ability of central bank to select its policy objectives without influence by the government. This political and economic dependence of the central bank in countries with high inflation experiences makes agents assign low credibility to the central bank's monetary

policy. Since these theoretical and empirical studies, legal central bank independence has been identified with a credible commitment to the price stability. This credibility bonus is presumed to be the source of the widely known negative correlation between central bank independence and average inflation rates.

However, despite the theoretical and policy attention paid to central bank independence, few studies have examined the postwar experience for evidence of credibility effects of central bank independence. If independent central banks' policies are inherently more credible, not only inflation levels but also expectations of monetary policy must differ systematically across countries with differences in central bank independence.

Very recently DeBelle and Fischer (1994), Walsh (1994), and Posen (1995) have tried to find the evidence of credibility effects by measuring disinflationary cost which is the ratio of output loss to the rate of disinflation. They adopted the idea that the greater credibility attributed to independent central bank should reduce the costs of subsequent policies to lower inflation. They estimated disinflationary costs in their sample countries and examined the relationship between these costs and central bank independence. In contrast to the idea, however, they found that disinflation appeared to be more costly and no more rapid in countries with more independent central banks.

DeBelle and Fischer (1994) used the disinflationary costs measured by Ball (1993) and compared the costs of Germany with those of United States and concluded that the disinflationary costs in Germany have been higher than those of United States.² Walsh

² Ball(1993) adopts a case study approach to estimating the sacrifice ratios associated with specific disinflationary periods for the developed countries. He identifies disinflationary episodes from the OECD data anytime inflation drops for four or more straight quarters after having risen(that is, peak to trough).

(1994) measured the costs of disinflation in twelve EC countries for the period 1973-1986 following Ball, Mankiw, and Romer (1988).³ He also found that those EC countries with greater central bank independence appear to also face higher costs of disinflation. Posen (1995) also has relied upon Ball (1993) to identify disinflationary episodes of seventeen countries from OECD data for the period 1950-1989 and also found a positive relationship between central bank independence and disinflationary costs.⁴ From the results, they argue that enhanced credibility does not appear to be the source of the negative correlation between central bank independence and lower inflation.

These studies, however, examined the relationship with the samples of developed countries which are considered to have more independent central banks than the other countries. For example, Debelle and Fischer (1994) examined the relationship only with two countries which have one of the most independent central banks in the world. They argued that improving central bank independence level of the Federal Reserves to the level of the Bundesbank would increase disinflationary cost and so that there is no credibility bonus. However, is the difference in independence level in these two highly independent central banks large enough to give us the no credibility bonus implication?

Since central bank independence is negatively correlated with average inflation rates and cost for reducing inflation increases when the level of inflation goes down, the positive relationship between disinflationary cost and the independence level may reflect

For each of these episodes Ball has computed a sacrifice ratio; total point-years of unemployment above that at episode start, divided by total points of inflation lost.

³ Twelve EC countries are Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, and United Kingdom. Ball, Mankiw, and Romer report a tradeoff parameter that measures the extent to which a nominal shock affects real output. This parameter is the estimated coefficient on the growth rate of nominal income in an equation for the level of real output. The lagged level of output and a time trend are also included in the regression and results are reported for 43 countries.

increasing marginal costs of disinflation.⁵ Then, this sample bias to highly independent central bank countries may not capture the proper credibility bonus problem in the economies. Extending the sample to include more countries which have low central bank independence may reveal a different relationship between central bank independence and disinflationary costs. However, since there is no central bank independence measurement which can be applied to both developed countries, which are considered to have highly independent central banks, and developing countries, which are considered to have low independent central banks and there are not enough data to measure disinflationary costs in developing countries, it is difficult to examine the relationship between disinflationary costs and central bank independence with the extended sample of countries. Though I will not reexamine the relationship with extended data, this paper shows another way to find a credibility bonus effect of central bank independence. To prove the credibility bonus effect, we will directly examine the relationship between central bank independence and monetary policy effects with the data of developed countries.

The purpose of this paper is to examine the possibility that the degree of monetary policy effect could differ across countries among which central banks have different levels of independence. One of the most pervasive real effects long-claimed for monetary policy is its ability to affect interest rates in the short run through channels other than the standard-expected inflation effect. The alleged short-term inverse relationship between interest rates and monetary policy is called the “liquidity effect” of monetary policy. In

⁴ The countries are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Spain, Switzerland, United Kingdom, and United States.

⁵ Walsh(1995), however, found that the tradeoff parameter from Ball, Mankiw, and Romer was significantly and positively related to central bank independence even after controlling for average inflation in a cross section of EC countries.

this paper, we focus on the liquidity effect to estimate the impact of monetary policy in each country, then, concentrate on the relationship between central bank independence and the liquidity effect in order to examine if monetary policy effects are influenced by central bank independence (CBI).

The negative relationship between CBI and inflation rates which are found by many empirical studies gives us the possibility of testing whether or not the monetary policy effects are smaller in low CBI countries than in high CBI countries because of high inflation experiences and low credibility of central bank policies in the low CBI countries. Regarding the liquidity effect, therefore, it would also be smaller in low CBI countries if the inflation expectation effect dominates the liquidity effect in a short period of time after a monetary policy disturbance. So, the length of the period which the liquidity effect dominates the inflation expectation effect after a monetary shock would be shorter. If the responses of interest rates to a monetary shock are smaller in low CBI countries, changes in the economic variables that respond to monetary policy through interest rates would also be smaller in the low CBI countries. This suggests that monetary policy effects would be smaller in low CBI countries than in high CBI countries.

This implies that to get the same effects on target variables from monetary policy, low CBI countries may need larger changes in the monetary policy variables that they control. Assume that a low CBI country decides to increase the money supply to stimulate the economy by lowering nominal interest rates. Because of the low credibility of the central bank's policy and the relatively weak effects of monetary policy on the economy, it may need a larger monetary expansion than a high CBI country does to lower interest rates to the same degree or the inflation expectation effect will dominate the liquidity effect more

quickly after the monetary expansion. Further, this higher monetary expansion in the low CBI countries would induce higher inflation rates in the future than in high CBI countries. This negative relationship between CBI and liquidity effect, therefore, could produce a vicious cycle which shows a strong relationship between CBI and inflation rates across countries. This expected negative relationship between CBI and liquidity effect can be shown as the following graph.

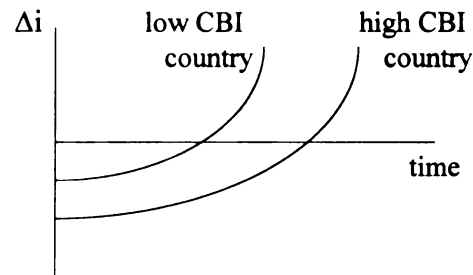


Figure 1. Expected Liquidity Effects after Monetary Shock

In low CBI country, the response of interest rates would be smaller and less persistent than in high CBI country. In some period of time after monetary expansion, the inflation expectation effect would be stronger than the liquidity effect so the changes in interest rates would turn positive. We can expect that this turning point after the monetary shocks would come sooner in low CBI countries than in high CBI countries. The graph, therefore, shows that expected liquidity effect would be weaker and be sustained for less time in low CBI country than in high CBI country.

The organization of this paper is as follows. Chapter II describes the indexes for central bank independence and sample countries used in this paper and reexamines the

relationship between CBI and inflation rates with extended data. In chapter III, we find a theoretical implication regarding the relationship between CBI and liquidity effect through a model economy approach. Then, with a group of the countries which show the negative relationship between CBI and inflation rates, we estimate liquidity effects by using traditional approaches and examine the possible relationship between CBI and liquidity effects across countries. In chapter IV, we construct both non-structural and structural VAR models to isolate liquidity effects and identify the monetary shock and examine the relationship between CBI and liquidity effects. The conclusions from this analysis are summarized in chapter V.

CHAPTER II

CENTRAL BANK INDEPENDENCE AND INFLATION

1. Index for Central Bank Independence

It is difficult to measure the degree of legal independence a central bank has, let alone the degree of its actual independence from government. Cukierman (1992) has pointed out that actual, as opposed to formal, independence hinges not only on legislation, but on many other factors such as informal arrangements with the government, the quality of bank personnel, and the personal characteristics of the key individuals at the bank. Because such factors are impossible to quantify, most research has focused on legal independence and for the most part analysis is restricted to the industrial countries.

There are different measurement of CBI developed by different researchers.⁶ Most frequently used indexes include those of Bade and Parkin (1988) which were extended by Alesina (1988), Grilli, Masciandaro, and Tabellini (1991), Alesina and Summers (1993) and Cukierman, Webb, and Neyapti (1992).

Bade and Parkin investigates the cross-country relationship between monetary policies and the laws which establish and delimit the powers of central banks. The study is empirical and deals with the experience of twelve industrial countries during the floating

⁶ Pollard (1993) provides a good survey paper regarding various CBI indexes.

exchange rate years 1972 to 1986.⁷ They describe the central bank laws of the twelve countries focusing on three features : i) The relationship between central bank and government in the formulation of monetary policy; ii) The procedures for appointing the board of the central bank, and ; iii) The financial and budgetary relations between central bank and the government. On the basis of features i) and ii) they classify the twelve central banks according to their degrees of policy independence. On the basis of feature iii) they identify the degree of financial independence from government.

Alesina uses the Bade and Parkin index of policy independence to illustrate the relationship between the degree of politico-institutional stability and economic performance. Alesina extends the Bade and Parkin's sample of countries to include Denmark, Finland, New Zealand, Norway, and Spain. The numerical values of Alesina index of central bank independence are identical to those of the Bade and Parkin index of policy independence, except for the case of Italy.⁸

Grilli, Masciandaro, and Tabellini (GMT) compare the monetary regimes of eighteen industrial countries during post-war period (1950-1989) by focusing on political and economic independence of central bank.⁹ According to GMT, political independence is the capacity to choose the final goal of monetary policy, such as inflation or the level of economic activity. Their index of political independence is primarily determined by the following features: i) Relationships between central banks and government in the

⁷ Twelve countries are Australia, Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, and United States.

⁸ "Bade and Parkin's classifications disregard institutional changes in the period considered. The Italian Central Bank obtained more economic independence in 1982. Given this change we classify Italy as 1.5 rather than 2, as in Bade-Parkin."(Alesina, 1988, p.42)

⁹ Eighteen countries are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Portugal, Spain, Switzerland, United Kingdom, and United States.

formulation of monetary policy; ii) Procedures for appointing the board of the central bank and; iii) Formal responsibilities of the central bank with the respect to monetary policy. The first two features are the same as those of Bade and Parkin. The overall index of policy independence is determined by a combination of these attributes. The economic independence considers the ability of the government to determine the conditions under which it can borrow from the central bank and the monetary instruments under the control of the central bank. Generally, the total score for both political and economic independence is employed as an indicator for legal independence.

Alesina and Summers do not add any new criteria for their central bank independence index. They use the average value of Bade and Parkin (BP) and Grilli, Masciandaro and Tabellini after constructing conversion from the GMT scale to a 1 to 4 scale comparable with BP scale.

As a more recent index, Cukierman et. al. code the legal central bank independence following two principles. First, they code only a few narrow but relatively precise legal characteristics and second, they use only the written information from the charters.¹⁰ They group the legal characteristics of the central bank as stated in its charter into four clusters of issues: i) The appointment, dismissal, and terms of office of the chief executive officer of the bank - usually the governor, ii) The policy formulation cluster, which concerns the resolution of conflicts between the executive branch and the central bank over monetary policy and the participation of the central bank in the budgetary

¹⁰ Cukierman et. al. develop four measures of central bank independence in their article. An aggregate legal index is developed for four decades in 72 countries. In addition, they develop other three indicators of actual independence which are the rate of turnover of central bank governors, an index based on a questionnaire answered by specialists in 23 countries, and an aggregation of the legal index and the rate of turnover.

process, iii) The objectives of the central bank, and iv) Limitations on the ability of the central bank to lend to the public sector; such restrictions limit the volume, maturity, interest rates, and conditions for direct advances and securitized lending from the central bank to the public sector. Then, they aggregate the numerical coding for each different legal variables and rank countries according to their aggregate variables for legal central bank independence for each decade from 1950 to 1989.¹¹

Table 1 presents these four indexes of central bank independence of eighteen countries which we will use to estimate the effects of CBI in this paper. These countries are the same as those in Fischer (1994). As we can expect from the fact that all these different studies consider very similar factors for making their indexes of central bank independence, from the table we can point out that all agree that Germany and Switzerland have the most independent central banks and there exists a rough consensus on CBI measures.

There are, however, a few countries which are ranked quite differently by the several measures. As we can see, the Bank of Japan has the third lowest independence level of all 18 countries according to Cukierman, while it has much higher level of independence in index of Alesina and Summers. This discrepancy over the degree of independence comes not only from differences in factors considered in measuring independence, but also from the criteria of independence as well.

The argument for the Bank of Japan's higher rank of independence in Alesina and Summers come from Bade and Parkin and GMT because Alesina and Summers' index is the average value of those of Bade and Parkin and GMT. Bade and Parkin claimed that

¹¹ We examine the variables for legal central bank independence in detail at the last part of this chapter.

Table 1. Index for Central Bank Independence

	BPA	GMT	AS	Cukierman
Australia	1	9	2 (8)	0.36 (8)
Austria	-	9	-	0.62 (2)
Belgium	2	7	2 (8)	0.17 (16)
Canada	2	11	2.5 (4)	0.45 (6)
Denmark	2	8	2.5 (4)	0.50 (4)
Finland	2	-	-	0.28 (11)
France	2	7	2 (8)	0.27 (12)
Germany	4	13	4 (1)	0.69 (1)
Italy	1.5	5	1.75 (14)	0.25 (13)
Japan	3	6	2.5 (4)	0.18 (15)
Netherlands	2	10	2.5 (4)	0.42 (7)
New Zealand	1	3	1 (16)	0.24 (14)
Norway	2	-	2 (8)	0.17 (16)
Spain	1	5	1.5 (15)	0.14 (18)
Sweden	2	-	2 (8)	0.29 (10)
Switzerland	4	12	4 (1)	0.57 (3)
United Kingdom	2	6	2 (8)	0.32 (9)
United States	3	12	3.5 (3)	0.48 (5)

Note : The value in parentheses is the relative ranking. The GMT measure is the sum of the indices for political and economic independence.

the Bank of Japan is independent from the government in formulating and implementing monetary policy and GMT claimed that there are no provisions for handling policy conflicts between the Bank of Japan and the government. In contrast, Cukierman argues that the Bank of Japan and the government formulate policy jointly and in the case of a policy conflict, the government makes a final decision.

This difference is confirmed by Table 2, which shows Spearman rank correlation coefficients of the various measures. The values above the diagonal indicate rank order correlation in the eighteen countries and the values below the diagonal are the correlations when we exclude Japan from the sample countries. The correlation of Bade and Parkin with Cukierman's legal independence has the lowest value while the correlation of GMT with Alesina and Summers' CBI index has the highest value. The correlation of GMT to Alesina and Summers' CBI index goes up to 0.96 when we exclude Japan from the sample countries. This high correlation results come from the fact that Alesina and Summers use the average values of Bade and Parkin and GMT.

Since Alesina and Summers' measurement represents both Bade and Parkin and GMT indexes, the most interesting statistics are the correlations of Alesina and Summers' index with Cukierman's index. These are 0.78 in 18 countries and 0.89 when Japan is excluded. These high correlations confirm that these different authors have very common ideas when they set the independence level of central banks of different countries. Therefore we can expect that the our results will be little affected by our choice of CBI indexes for estimation.

Table 2. Rank-correlation of CBI indexes

	BPA	GMT	AS	Cukierman
BPA	-	0.69	0.88	0.53
GMT	0.80	-	0.89	0.82
AS	0.88	0.96	-	0.78
Cukierman	0.67	0.83	0.89	-

All those indexes mentioned above are legal measures of central bank independence but there are also nonlegal measures of central bank independence. Cukierman (1992) and Cukierman et. al. (1992) have developed a nonlegal index for CBI based on the actual average term of office central bank governors. This indicator is based on the presumption that a higher turnover of central bank governors indicates a lower level of independence, at least above some threshold, and that even if the central bank law is quite explicit, it may not be operational if a different tradition has precedence. For example, in Argentina, the legal term of office of the central bank governor is four years but there is also an informal tradition that the governor will resign whenever there is a change of government, or even a new finance minister. The actual average term of office of the central bank governors during 1980s were only ten months. This suggests that the turnover rate of central bank governors can be a good indicator for the degree of CBI.

Cukierman and Webb (1995) have developed another nonlegal index of CBI. They argue that the frequency of transfers of central bank governors reflects both the frequency of political change and the percentage of political changes that are followed by changes in the governorship of the central bank. They develop an indicator of the political

vulnerability of the central bank, which is defined as the percentage of political transitions that are followed within six months by the replacement of the central bank governor. For the period from 1950 to 1989, the average index of political vulnerability is 0.24 for whole sample countries, 0.10 for industrial countries, and 0.34 for developing countries.

Those existing legal and nonlegal indexes of CBI are often incomplete and noisy indicators of actual independence. However, this does not mean that they are uninformative. As Cukierman (1995) pointed out, their use should be supplemented by judgment of the problem under consideration.

In this paper, we will use Cukierman's legal CBI index which seems to be most widely used. We, however, will use Alesina and Summers' as well as Cukierman's to reexamine the relationship between CBI and inflation rates in 18 developed countries, since we want to see here if we can replicate existing results with the same index and method they used. In chapter III and IV, the number of sample countries we examine is decreased from 18 to 12 because of non-availability of the data in some countries and we will exclude Japan from the sample countries even though we can get easily all data for Japan since the estimated results are somewhat affected by which CBI index we choose for Japan.¹²

For developing countries, Cukierman argues that the actual frequency of change of the chief executive officer of the bank is a better proxy for central bank independence, since the divergence between the letter of the law and actual practice seems substantially higher

¹² In section III and IV, when we include Japan in the sample countries, Alesina and Summers' index for CBI gives us more significant results in most cases than does Cukierman's index. However, the differences in significance level between two estimation results are within 4 percent.

in developing countries than in industrial countries. Therefore we will follow Cukierman and use the turnover rate of central bank governors as CBI index for those developing countries.

2. Central Bank Independence and Inflation in Developed Countries

Before we explore the possible relationship between CBI and liquidity effects, we briefly reexamine the relationship between CBI and inflation rates in developing countries as well as developed countries to get the proper sample of countries for the next sections. Many researchers have found a negative relationship between CBI and inflation rates in developed countries. Among them, Bade and Parkin investigate the relationship between central bank types and monetary policy in twelve countries. In their analysis of monetary policy they focused on two aspects; its inflation level and the variability of inflation. They find that the two most independent central banks, those of Germany and Switzerland, have achieved a lower inflation rate than the other central banks. Also, they point out that the mean inflation rate of the eight government dominated central banks is in excess of ten percent.¹³ On the basis of these facts Bade and Parkin conclude that there is an association between degree of central bank policy independence and the average rate of inflation.

Grilli, Masciandaro, and Tabellini find that economic independence was negatively related to inflation in eighteen OECD countries over the period 1950-1989. Political

independence also had a negative correlation with inflation, but the relationship was not statistically significant. Breaking the data into four decade-long subperiods, they find that neither measure of independence has a significant effect on inflation in the first two decades. In the 1970s both measures of independence are significant while in the 1980s only the economic independence is significant.

Alesina & Summers (1993) find a negative correlation between the inflation rates and the level of CBI in 16 industrialized countries for the period of 1955-1988 and also find that the more independent a central bank, the less variable inflation. On the other hand, they found no correlation between the level of CBI and average economic growth or the variability in economic growth. With these results, they argued that a higher CBI results in lower inflation rates without any side effects on real economic variables. Fischer (1994) found the same relationships as Alesina and Summers did, using only the GMT index for 18 industrialized countries for the period of 1960-1992

Cukierman (1992) provides the most comprehensive analysis of central bank independence and its relationship to inflation performance using data for 1950-1989 with a sample of 73 countries. He concludes that the legal independence level has a statistically significant coefficient with the predicted negative sign for the industrial countries so that laws do make a difference.¹⁴ His estimation shows that 0.1 point increase in legal independence index might increase the real value of money by 0.5%.

¹³ They are Australia, Belgium, Canada, France, Italy, Netherlands, Sweden, and United Kingdom.

¹⁴ Actually, Cukierman did not use the inflation rate. He used the real depreciation of a given amount of money by transforming each year's inflation rate into inflation divided by one plus the inflation rate and then taking the geometric average for the decade. This transformed inflation is also used in Cukierman et. al. (1992)

However, even though these empirical studies show a negative correlation between central bank independence and the inflation rate, this inverse relationship does not necessarily imply a causal relation from central bank independence to inflation, since low independent level of central bank may result from high inflation experiences or other factors in the countries which also leads to high inflation.¹⁵ Despite of the causality problem, the previous empirical studies have been based on the argument that central bank independence has a significant effect on inflation rates. For example, Schaling (1995) argues as follows to examine the relationship between central bank independence and inflation rate.

“... the degree of central bank independence is the ultimate cause of the level of inflation. For central bank independence is the ability and willingness to conduct an autonomous monetary policy directed at price stability as the single policy goal. If not seriously hampered by other elements of economic policy, such as wage increases, budget deficits, and government debt, it will eventually lead to low sustainable inflation...” (Schaling, 1995, p.122)

In this paper we use Cukierman’s legal independence and Alesina & Summers’ index for 18 developed countries.¹⁶ Since Cukierman’s index is the most comprehensive one and Alesina & Summers’ index is the average value of those of Bade and Parkin and GMT, these two indexes are thought to be the most representative ones. The 18 developed countries are the same as those of Fischer (1994).

¹⁵Cukierman et.al. (1992) did a simple Granger causality test by estimating the bivariate autoregressive processes for inflation and turnover. They find that the coefficient of lagged turnover in the inflation equation is highly significant, as is the coefficient of lagged inflation in the turnover equation. They conclude that these results imply that there is a vicious circle between inflation and low levels of CBI.

¹⁶ The eighteen countries are those in Table 1.

Furthermore, we examine not only the relationship between CBI and inflation rate but also the relationship between CBI and the M1 growth rate.¹⁷ Central banks can affect the inflation rate through controlling a money aggregate with various monetary policies. Therefore we can assume that countries which have less independent central banks will experience higher M1 growth rates and these higher M1 growth rates increase the countries' inflation rate. This means that even though the inflation rates are high in low CBI countries, if the M1 growth rates do not have concrete relationships with the degrees of CBI, we can not say that CBI has a direct effect on the inflation rate.

We estimate the relationship during 1960-1995 period and the post-Bretton-Woods periods 1972-1995. During the fixed exchange rate system of Bretton-Woods countries were fully committed to an exchange rate target and had no room to conduct autonomous domestic monetary policy. Thus, before 1972 the empirical relation between CBI and inflation was much less straightforward than after 1972.¹⁸

With a sample of eighteen developed countries we can replicate the previous results no matter which index is used for CBI. Although the relationships between the M1 growth rate and CBI are weaker than those between inflation rates and CBI, simple regression show that CBI has negative effects on inflation rates through its effect on M1 growth in developed countries. Figure 2 shows this estimated negative relationship for some sample periods and Table 4 reports the regression results.

¹⁷ We use M1 data because M1 is the only monetary aggregate which is available for all countries.

¹⁸ We neglect the other exchange rate policy factor in Europe. Some European countries(EMS countries) participates in the snake arrangement before 1982.

Table 3. CBI, Inflation rate, and M1 growth rate in developed countries

	<u>CBI(Legal Independence)</u>		<u>Inflation rate</u>		<u>M1 growth rate</u>	
	'60-'90	'70-'90	'60-'95	'72-'95	'60-'95	'72-'95
Germany	0.69	0.69	3.36 (1.75)	3.68 (1.94)	8.16 (3.57)	8.19 (4.06)
Austria	0.62	0.61	4.23 (1.97)	4.57 (2.25)	7.28 (3.95)	7.01 (4.77)
Switzerland	0.57	0.59	3.75 (2.20)	3.90 (2.52)	5.49 (3.53)	6.43 (6.62)
Denmark	0.50	0.50	6.33 (3.49)	6.75 (3.96)	10.84 (7.83)	11.41 (9.32)
U.S	0.48	0.48	4.74 (3.10)	5.72 (3.19)	6.39 (3.13)	7.63 (2.87)
Canada	0.45	0.45	5.01 (3.30)	6.20 (3.38)	8.05 (6.65)	8.90 (6.79)
Netherlands	0.42	0.42	4.36 (2.76)	4.34 (3.09)	7.95 (4.09)	7.44 (4.51)
Australia	0.36	0.36	6.30 (4.14)	8.01 (3.95)	9.29 (6.64)	11.89 (6.25)
Sweden	0.29	0.29	6.62 (3.15)	7.81 (3.06)	6.13 (8.33)	9.12 (2.86)
Finland	0.28	0.28	6.80 (4.30)	7.71 (4.71)	16.13(27.43)	20.00(32.98)
U.K	0.32	0.27	7.29 (5.34)	8.81 (5.82)	9.74 (6.51)	12.77 (5.59)
Italy	0.25	0.25	8.42 (5.74)	10.70 (5.69)	14.31(10.03)	13.45 (6.27)
New Zealand	0.24	0.24	7.83 (5.40)	9.70 (5.49)	10.33(11.67)	14.20(12.46)
France	0.27	0.24	6.00 (3.74)	6.92 (4.21)	8.63 (5.16)	7.88 (4.93)
Japan	0.18	0.18	4.99 (4.34)	4.67 (5.24)	11.96 (8.03)	8.22 (6.07)
Belgium	0.17	0.17	4.52 (3.04)	5.32 (3.34)	5.58 (3.66)	5.65 (3.77)
Norway	0.17	0.17	6.06 (3.29)	6.93 (3.31)	12.54 (7.06)	14.87 (7.33)
Spain	0.14	0.16	9.35 (5.45)	11.04 (5.63)	13.98 (6.20)	14.83 (6.68)

Note : Countries are ordered by the level of CBI for the period of 1970-1990. The standard deviations are reported in parentheses.

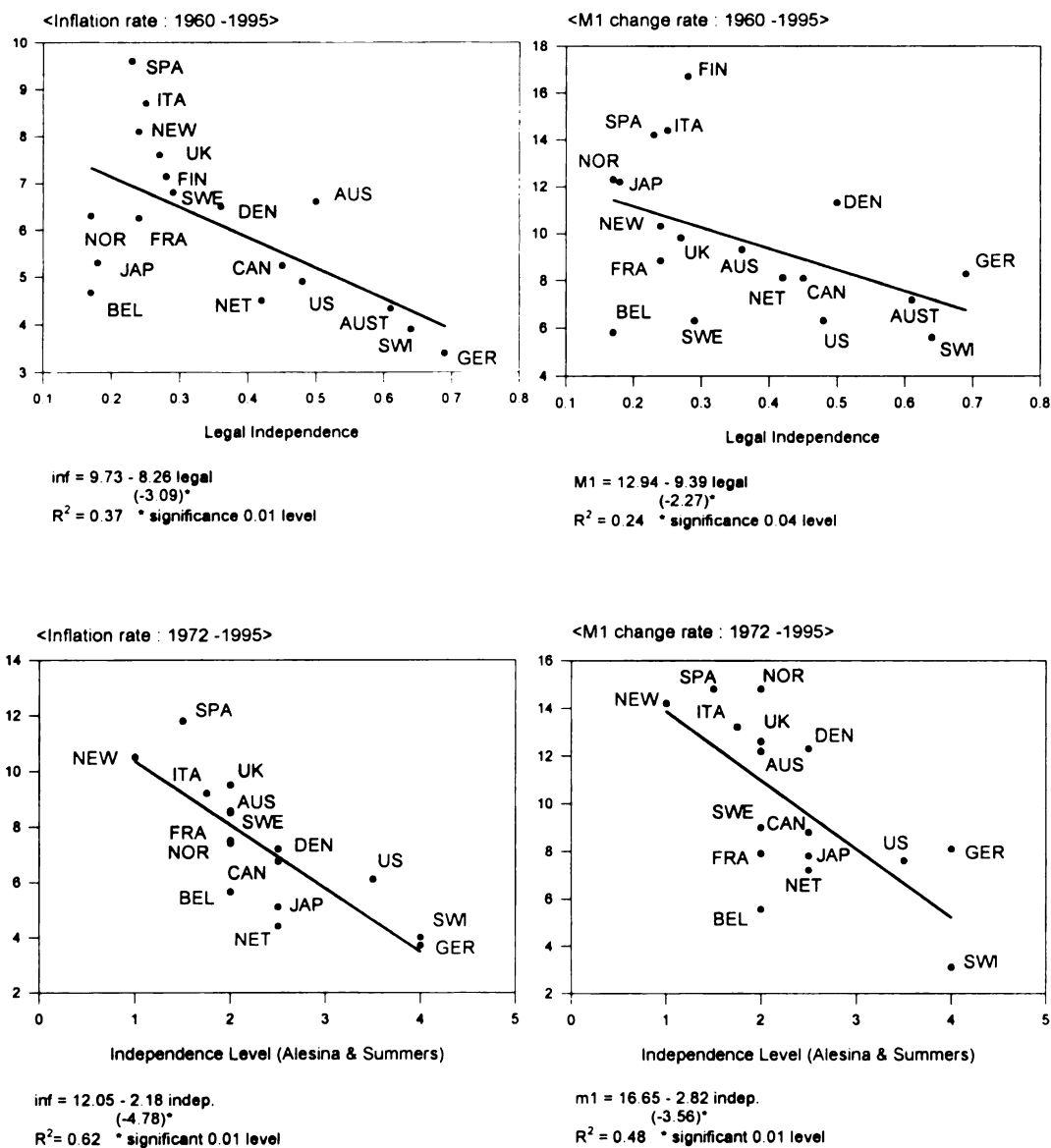


Figure 2. CBI vs. Inflation rate and M1 Growth rate in Developed Countries

Table 4. Inflation rate and M1 growth rate vs. the CBI

	Dependent Variables	Explanatory Variables	Alesina & Summers	Cukierman
1960-1995	Inflation rates	Intercept	9.77	8.20
		CBI	-1.63*** (-5.02)	-6.51*** (-3.43)
		R ²	0.64	0.42
	M1 growth	Intercept	13.45	12.94
		CBI	-1.74* (-2.25)	-9.39* (-2.27)
		R ²	0.27	0.24
1972-1995	Inflation rates	Intercept	12.05	9.73
		CBI	-2.18*** (-4.78)	-8.26*** (-3.09)
		R ²	0.62	0.37
	M1 growth	Intercept	16.65	14.47
		CBI	-2.82*** (-3.56)	-11.57* (-2.16)
		R ²	0.48	0.23

Note : The t-statistics are reported in parentheses. * indicates significance at the 5 percent level, ** at 3 percent level, and *** at 1 percent level.

We also find a very significant negative relationship between the variance of inflation rates and CBI during both 1960-1995 and 1972-1995 periods no matter which index is used for CBI. The variance of M1 growth also has a negative correlation with Alesina and Summers' index, but it does not have a significant relationship with Cukierman's index. This negative relationship seems to be a result of a correlation between the level and variability of inflation (or M1 growth) as argued by Alesina and Summers. The regression results are reported in Table 5.

In summary, our estimation results confirm that CBI has a significant effect on the inflation rate in the developed countries. CBI also seems to have an effect on a central bank's decision how to conduct monetary policy. In developed countries, highly independent central banks seem to be more conservative in increasing monetary aggregate growth and they are better in reducing the inflation rate than low independent central banks.

Table 5. Variance of Inflation rate and M1 growth rate vs. the CBI

	Dependent Variables	Explanatory Variables	Alesina & Summers	Cukierman
1960-1995	Variance of Inflation	Intercept	6.40	5.53
		CBI	-1.12*** (-4.59)	-5.16*** (-3.95)
		R ²	0.60	0.49
	Variance of M1 growth	Intercept	10.39	10.91
		CBI	-1.62** (-2.65)	-9.38 (-1.19)
		R ²	0.33	0.08
1972-1995	Variance of Inflation	Intercept	6.49	5.81
		CBI	-1.06*** (-3.88)	-5.31*** (-4.08)
		R ²	0.52	0.51
	Variance of M1 growth	Intercept	8.95	9.76
		CBI	-1.24* (-1.77)	-6.54 (-0.65)
		R ²	0.18	0.03

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level , ** at 3 percent level, and *** at 1 percent level.

3. Central Bank Independence and Inflation in Developing Countries

All studies except Cukierman (1992) and Cukierman et.al. (1992) restrict the samples to developed countries to examine the effects of CBI on the economy. Cukierman (1992) developed four measures of central bank independence and explores their relations with inflation. He examined these relationships in the cases of developing countries as well as developed countries. He found that legal independence was inversely related to inflation in industrial countries as was the turnover rate of central bank governors positively related to inflation in developing countries.

In this paper, we use the turnover rate of central bank governors for 27 developing countries as the index of CBI following Cukierman's finding which indicates that a legal index of independence is not useful for studying developing countries.¹⁹ The 27 developing countries are countries for which both macroeconomic time series data and turnover rates of central bank governors are available.

However, even though we use the same index as Cukierman did, our estimation result does not support Cukierman's findings (1992) which show a significant relationship between CBI and inflation rates in developing countries since the results are strongly dependent on which countries are included in the model. We find no relationship between CBI and inflation rates in developing countries after excluding hyperinflation countries. Some possible explanations for this result will be discussed after showing the estimation results.

¹⁹ We estimate the relationship between legal CBI index and inflation rate in developing countries for 1972-1995 period. Contrary to the developed countries' case, the relationship is positive and insignificant.

For the estimation, we group the developing countries as follows; Group I includes all 27 developing countries for which data are available and Group II includes 23 developing countries after excluding Argentina, Brazil, Israel and Peru which experienced hyperinflations. We exclude those 4 countries from Group I to formulate Group II.

Since these countries have experienced very high inflation rates during 1970-80's and there is a strong possibility that these hyperinflation rates, which were higher than hundreds percent or even thousands percent a year, might come as the result of abnormal macroeconomic behavior, political instability, or regional war in these countries. Therefore, it may be reasonable to exclude these countries from the sample developing countries to examine more general influences of CBI on macroeconomic variables.

For example, every year Argentina experienced inflation rates which were higher than 100% a year during 1975-1991 period - particularly for 1989-1990 annual inflation rates were almost 3000% and changed the central bank governor more than once per year. Such frequent changes in the central bank governor might induce high inflation rates, or the government might dismiss the governor frequently because of his responsibility for high inflation. Whichever is true, there is a great possibility that these very high correlations between CBI and turnover rate dominated in Cukierman's result. We examine the relationship between M1 growth and the turnover rate as well as between the inflation rate and the turnover rate in each group. Figure 3 depicts the relationship for the period 1960-1995.

Table 6. CBI, Inflation rate, and M1 growth rate in developing countries

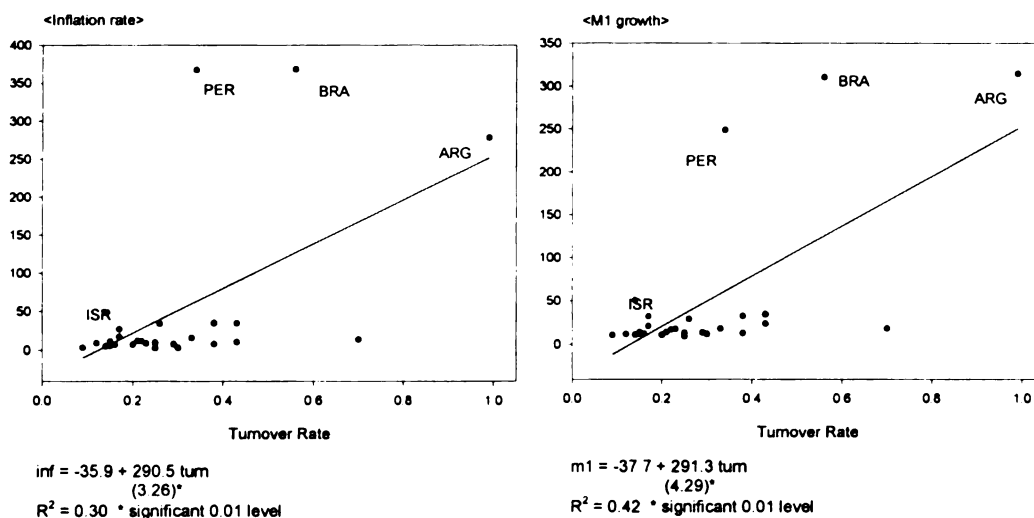
	<u>CBI(turnover rates)</u>		<u>Inflation rate</u>		<u>M1 growth rate</u>	
	'60-'90	'72-'90	'60-'95	'72-'95	'60-'95	'72-'95
Malaysia	0.09	0.10	3.42 (3.56)	4.68 (3.63)	10.65 (8.62)	13.53 (7.56)
South Africa	0.12	0.10	9.40 (5.26)	12.65 (2.86)	11.73 (9.35)	14.80 (10.12)
Thailand	0.14	0.18	5.27 (5.51)	7.04 (5.84)	10.88 (5.88)	12.77 (6.22)
Israel	0.14	0.17	48.75 (81.61)	70.21 (93.22)	50.93 (69.59)	69.59 (79.96)
Philippines	0.15	0.10	11.48 (9.75)	13.85 (10.60)	13.75 (6.39)	15.97 (5.61)
Morocco	0.15	0.10	5.99 (4.12)	7.79 (3.73)	12.20 (5.51)	13.78 (4.54)
Honduras	0.16	0.24	7.36 (7.34)	10.16 (7.62)	12.00 (7.97)	14.07 (8.06)
Mexico	0.17	0.22	27.25 (33.85)	39.31 (35.85)	32.07 (27.36)	43.07 (27.95)
Nigeria	0.17	0.18	17.18 (17.44)	23.34 (18.31)	20.98 (22.13)	26.41 (23.76)
Ethiopia	0.20	0.30	7.37 (9.53)	8.78 (10.08)	10.87 (9.19)	13.83 (7.55)
Portugal	0.21	0.28	12.15 (8.43)	16.05 (7.66)	13.84 (7.26)	17.09 (6.66)
Greece	0.22	0.29	11.88 (8.29)	16.77 (5.39)	16.93 (4.30)	18.48 (3.41)
Nepal	0.23	0.18	8.98 (5.96)	10.04 (5.18)	17.50 (7.23)	17.13 (5.42)
Egypt	0.25	0.22	10.01 (7.29)	13.69 (5.41)	13.16 (7.45)	16.52 (5.97)
Panama	0.25	0.10	3.06 (3.73)	4.01 (4.28)	9.03 (11.18)	9.80 (12.90)
Ghana	0.26	0.23	34.43 (33.47)	42.33 (34.14)	29.03 (18.88)	39.00 (14.38)
Pakistan	0.29	0.28	8.11 (5.80)	10.22 (5.82)	13.38 (6.03)	15.54 (5.43)
Singapore	0.30	0.30	3.26 (4.93)	4.21 (5.69)	11.83 (6.15)	12.36 (6.17)
Venezuela	0.33	0.38	15.93 (20.03)	23.15 (21.11)	18.05 (19.83)	24.66 (21.06)
Peru	0.34	0.34	367.33(1345)	546.45(1629)	248.77(858.8)	368.17(1047)
Zambia	0.38	0.38	34.92 (51.29)	49.48 (57.06)	32.34 (31.28)	35.16 (34.27)
India	0.38	0.40	7.94 (5.97)	9.11 (6.34)	12.62 (5.43)	14.32 (5.83)
Korea	0.43	0.32	10.69 (7.34)	10.27 (7.98)	23.38 (11.52)	21.96 (11.19)
Turkey	0.43	0.39	34.53 (31.31)	49.40 (28.12)	34.43 (20.56)	45.19 (16.96)
Brazil	0.56	0.59	368.04(738.3)	531.17(863.7)	310.55(790.5)	454.35(959.3)
Costa Rica	0.70	0.64	14.01 (16.47)	19.88 (17.43)	18.20 (14.27)	22.92 (14.86)
Argentina	0.99	0.94	278.29(633.5)	411.45(752.4)	314.59(619.4)	371.94(628.7)

Note : Countries are ordered by the level of turnover rate for the period of 1960-1990. The standard deviations are reported in parentheses.

In Group I, we find a very significant relationship between turnover rates and either inflation rates or M1 growth rates as did Cukierman. The higher the turnover rates of the central bank governor, the higher the inflation rate. This means that more independent central banks are associated with lower levels of inflation (or M1 growth) as we expected. In Group I, however, the hyperinflation countries seem to have a very strong influence on the results of the regression. Since these hyper-inflation countries have relatively dependent central banks, their strong relationship between inflation rates and CBI dominates the relationship in all other countries and leads us to the same conclusion as we reached with the developed countries, no matter what relationship prevails in the other developing countries. Therefore, it is unreasonable to conclude that there exists a positive relationship between inflation rates and turnover rates in developing countries.

In Group II, we do not find any significant relationship between inflation rates and turnover rates, even though the significance level is as high as 0.01 in Group I. This confirms that the relationships in the four hyperinflation countries dominates in Group I, and that Cukierman's result may be biased by the hyperinflation countries in his sample. The relationships between M1 growth rates and turnover rates show the same patterns as those between inflation rates and turnover rates in the both groups. Therefore, these results do not support the previous view that there exists a negative relationship between inflation rates and CBI in developing countries.

1. Group I countries



2. Group II countries

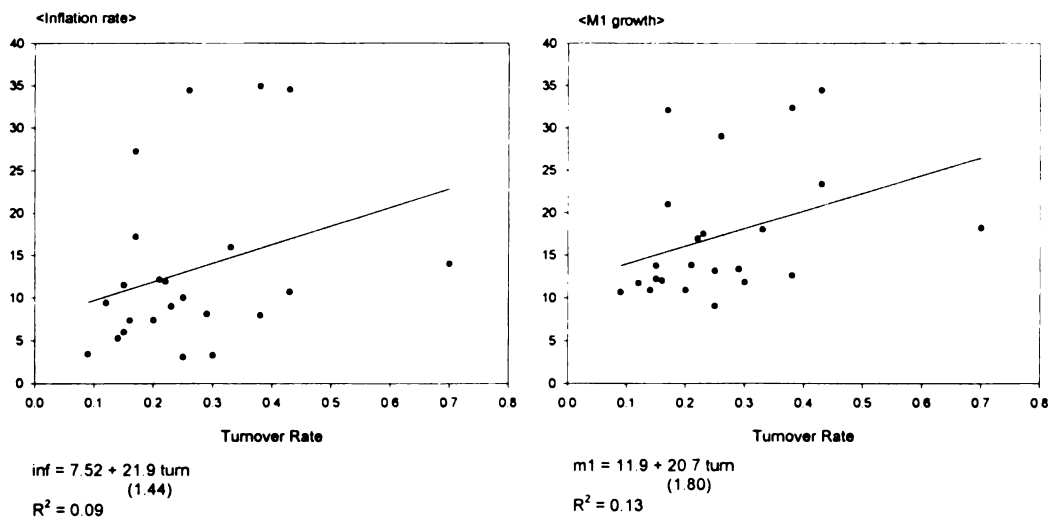


Figure 3. CBI vs. Inflation rate and M1 Growth in Developing Countries (1960-1995)

Table 7. Inflation rate and M1 growth rate vs. the CBI

	Dependent Variables	Explanatory Variables	Group I	Group II
1960-1995	Inflation rates	Intercept	-35.88	7.52
		CBI	290.51**	21.91
			(3.26)	(1.44)
		R ²	0.30	0.09
	M1 growth	Intercept	-37.71	11.92
		CBI	291.28**	20.73*
			(4.29)	(1.80)
		R ²	0.42	0.13
1972-1995	Inflation rates	Intercept	-66.57	8.16
		CBI	473.33**	36.96
			(3.52)	(1.66)
		R ²	0.33	0.12
	M1 growth	Intercept	-54.74	14.13
		CBI	405.92**	25.95
			(4.03)	(1.59)
		R ²	0.39	0.11

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 1 percent level.

We also find a positive relationship between variance of inflation rates and turnover rates in Group I during both 1960-1995 and 1972-1995 periods. The relationship is significant at the 3 percent level during both periods. This seems to be a result of a correlation between the level and variability of inflation as argued by Alesina & Summers (1993). In Group II, however, the relationship is not significant for the 1960-1995 period while it is significant at 10 percent level for 1972-1995 period. This result implies that CBI is neither correlated with the variance of inflation rates nor with the inflation rate in the developing countries of the Group II. Therefore, it may not be quite accurate to argue that more independence of central banks in developing countries has resulted in a lower variance of and a lower level of inflation rates. This is confirmed by the relationships between the variance of the M1 growth rates and turnover rates. In Group I, the relationship is significant at 1 percent level but it is not significant at all in Group II.

This argument, however, does not mean that high independence of central bank is not useful for achieving a low inflation rate in developing countries. That is, it suggests that there could be no relationship between CBI and inflation rate only across developing countries. However, if the level of CBI is increased in a country while other conditions remain constant, inflation rate could decrease as argued by previous analyses. The recent experiment of New Zealand gives us a good example.²⁰

²⁰ see F. Holmes (1994).

Table 8. Variance of Inflation rate and M1 growth rate vs. the CBI

	Dependent Variables	Explanatory Variables	Group I	Group II
1960-1995	Variance of Inflation	Intercept	-83.46	5.95
		CBI	666.46** (2.40)	28.24 (1.48)
		R ²	0.19	0.09
	Variance of M1 growth	Intercept	-96.15	8.03
		CBI	647.78*** (3.14)	14.81 (1.25)
		R ²	0.28	0.07
1972-1995	Variance of Inflation	Intercept	-121.75	3.86
		CBI	872.41** (2.51)	37.44* (1.75)
		R ²	0.20	0.13
	Variance of M1 growth	Intercept	-120.25	7.12
		CBI	783.34*** (3.05)	17.27 (1.29)
		R ²	0.27	0.07

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 3 percent level, *** at 1 percent level.

However, the one thing we need to note is that Cukierman (1992) and Cukierman et. al. (1992) did not use inflation rate itself. Actually, they use the transformed inflation rate in order to reduce heteroskedasticity of the error and thus improve the efficiency of the estimate. Cukierman et. al. argue the reason for using transformed inflation rate as follows:

“ .. Most countries had average inflation rates of 20 percent or less, but a few had three-digit inflation rates in some decades. Using the straight inflation rate would give undue weight to these outlier observations. So we transformed each year's inflation rate into inflation divided by one plus the inflation rate and then took the geometric average for the decade. This variable represents the annual real appreciation of a given amount of money; we call it D:

$$D = \pi / (1 + \pi)$$

where π is the inflation rate and D (hence, the transformed inflation rate) takes a value from 0 to 1. When inflation is 100 percent a year, D is 0.5. ..” (Cukierman et.al., p370)

In spite of their argument for using the transformed inflation rates, even if we use the transformed inflation rate, we find that the estimation result is still biased by these hyperinflation countries. In Group I, we find very significant relationship between transformed inflation and turnover rate during both periods. They are significant even at 0.1 percent level. However, in group II, this significant relationship disappears for the 1960-1995 period and the relationship is significant only at 10 percent level for the post Bretton Woods period.

The results of estimations for developing countries without the hyperinflation countries contradict the previous argument that CBI has important impacts on economic behavior in developing countries. I think there can be many explanations of this contradiction. First, the turnover rate may not be a proper index for CBI in developing countries. In some developing countries, a low turnover rate of central bank governors

Table 9. Transformed Inflation rate vs. Turnover rate

	Explanatory Variables	Group I	Group II
1960-1995	Intercept	0.029	0.064
	CBI	0.360 ** (4.04)	0.127 (1.52)
	R ²	0.40	0.10
1972-1995	Intercept	0.026	0.071
	CBI	0.509 ** (4.39)	0.213* (1.79)
	R ²	0.44	0.13

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 0.1 percent level,

does not mean that central bank has a high level of independence because a relatively subservient governor may stay in office for a long time, or because a long-term governor is sometimes an intimate person or even a relative of the president or the prime minister in some despotic states.²¹

Second, the utility function of the central bank in developing countries may be different from that of central banks in developed countries. In developing countries, a central bank may place more weight on other economic objects such as economic growth than on price stability regardless of its independence levels. Then we could find that some central banks have tried to reduce inflation rates while others have tried to pursue other objects. In this case, CBI will not have any concrete relationship with other economic variables across countries.

²¹ Cukierman (1992) argues that this may be true for countries with exceptionally low turnover rates, such as Denmark, Iceland, and the United Kingdom.

As a third explanation, there exists no relationship between CBI and economic performance in developing countries not because CBI is unimportant in these countries, but because level of CBI is too low to have an impact on the economy. Conversely, within the countries which have little CBI, the difference of CBI is unrelated to the difference in economic behavior. On the other hand, within developed countries, which have high independent central banks, many analyses show that the difference of CBI is strongly correlated with the difference in economic behavior. Therefore, we may suspect that CBI should be higher than some critical independence level in order to have some impacts on economic behavior. If CBI is below this level, the difference of CBI is unlikely to be one of the factors which characterize the economy.

We draw the following graph, Figure 4, by using the CBI data of Cukierman et. al. (1992) to see the significance of CBI in economy. The Y-axis represents the difference between fitted and actual inflation rates and the X-axis represents the overall independence level in their paper. The higher value on X-axis means the lower overall independence of central bank. The graph shows that the gap between fitted and actual inflation rates increases sharply when the overall independence of central bank decreases.

The large gap means that there exists no relationship between CBI and inflation rates because the error of estimation is too big for CBI to have a significance in the economy. Conversely, if CBI has a significant relationship with inflation we can expect small gap between the fitted and the actual inflation rates because the fitted value comes from a linear function of the independence level of the central bank. Hence, as the gap decreases, the relationship between CBI and inflation rates becomes stronger. The dotted line indicates the median of CBI (0.17) of 73 countries which includes the developing

countries as well as the developed countries. The overall indexes of all industrial countries are below the median - actually, all of those countries are below 0.11; and most of the developing countries are above the median.

Therefore, within the developing countries it is more difficult to find a relationship between CBI and inflation rates since the gap between fitted and actual inflation is much bigger than in the developed countries. If CBI increases to some levels above the median independence level the gap will decrease and we can expect much more stable relationship between CBI and economic performance in the developing countries. This gives an implication for countries which are going to reform their central banks by giving more independence to get some benefit from high CBI. It says that, if a country has the central bank which independence level is much below the median level, it is very difficult to get the effects they want with slight improvement of CBI, so that they may need much greater reform in central bank system in order to fulfill the purpose.

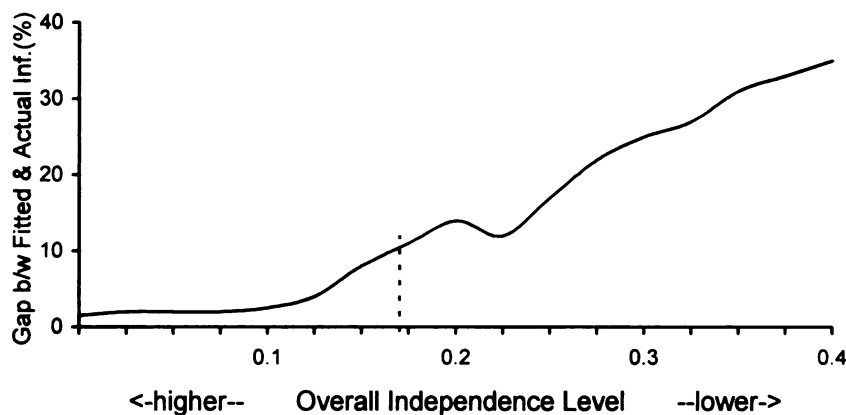


Figure 4. Gap between Fitted and Actual Inflation rate

4. Variables for Central Bank Independence and Inflation

Based on many studies which showed the inverse relationship between CBI and inflation rates and the success of the Bundesbank system in Germany, recently some countries are trying to reform the central bank system by giving more independence to the bank. However, it is uncertain which factors are really important in enhancing CBI level since there are many factors which affect the independence level of central bank. Among these factors, there can be some key elements which really contribute to improvement of CBI, while others are of little help for improving CBI. Therefore, although a country reforms the central bank system by raising overall CBI index, if there is not much improvements in these key factors which play important roles in the actual practice of central bank, it would be hard to get real effects of central bank reform.

Regarding this issue, it is very useful to examine the variables which are components of Cukierman's legal index. Cukierman's legal independence index consists of 4 categories which are subdivided into 16 different legal variables coded on a scale of 0 (lowest level of independence) to 1 (highest level of independence). These coded values are added up for each of the four categories, and finally the weighted average of the values for the four categories becomes the legal index. Table 10 summarizes these categories.

Table 10. Variables for legal independence index.

Variables	weight	Variables	weight
1. CEO variables	0.20	4. Limitation on lending to the government	0.50
a. Terms of office	(0.05)	a. Limitation on nonsecuritized lending	(0.15)
b. Who appoints CEO?	(0.05)	b. Securitized lending	(0.10)
c. Dismissal procedure	(0.05)	c. Terms of lending	(0.10)
d. Possibility of holding other office	(0.05)	d. Potential borrowers from the bank	(0.05)
2. Policy formulation	0.15	e. Limits on central bank lending	(0.025)
a. Who formulate monetary policy	(0.05)	f. Maturity of loans	(0.025)
b. Who has final word in resolution of conflict	(0.05)	g. Interest rates on loans	(0.025)
c. Role in government's budgetary process	(0.05)	h. Primary market prohibition	(0.025)
3. Central bank objectives	0.15		

Using data of 18 developed countries, first we regress each of 16 variables on inflation rates. All coefficients but one have negative signs, which confirm the inverse relationship between legal independence and inflation rates. Among these 16 coefficients, the coefficients of the final authority variable in policy formulation category and some variables in limitation on lending category are significant. The final authority variable and the securitized lending variable have inverse relationships with inflation rates at significance level 0.03. Although the relationship between inflation rate and each sixteen legal variables give us an idea which ones are more important factors for CBI, the relationship between four categories and inflation rate has more general implication since each sixteen legal variables has a different weight to make four categories and this

combination of each legal variable can draw a different result regarding the relationship with inflation rate.

Therefore, next we regress the four categories on inflation rates. The results are reported in Table 11. From these results, it is obvious that the most important variables for CBI are both the variables concerning the policy initiatives of the central bank in the decision making process and the variables concerning the conditions attached to central bank credit to the government. The relationship either between policy variable and inflation rates or between combinations of policy and credit variable are a little stronger than the relationship between overall legal independence and inflation rates. The variables regarding CEO or bank objectives have no relationship with inflation rates at all. If we make a new CBI index using only policy and credit variables, it shows a more significant inverse relationship with inflation rates than does the overall legal independence level.

Table 11. Variables for CBI vs. inflation rates (1972-1995)

Intercept	7.40	8.27	6.99	8.79	8.96	9.00	9.73	8.54
CEO	-5.99 (-0.38)							2.21 (0.18)
Policy		-51.91** (-3.25)			-36.53* (-1.95)			-37.62* (-1.90)
Objective			-0.49 (-0.28)					1.21 (0.81)
Lending				-12.30** (-2.86)	-7.00 (-1.46)			-8.17 (-1.56)
Real CBI						-11.60** (-3.32)		
Overall legal index							-8.26** (-3.09)	
R ²	0.01	0.40	0.01	0.34	0.47	0.41	0.37	0.50

Note : The t-statistics are reported in parentheses. Real CBI is the weighted sum of policy and lending variable.* indicates significance at the 10 percent level, ** at 1 percent level.

This implies that even though a country raises the degree of central bank independence through reforming the variables like the term of office for the central bank governor or the objectives of central bank, it might not contribute to real CBI enhancement. Since the result suggests that real improvement of CBI comes from reforming variables which are directly related with actual monetary policy, not from improving formal variables like literal objectives of the central bank, the central bank might not have real independence as long as the bank does not have certain degree of independence in executing monetary policy.

5. Summary

In this chapter, we examined the various CBI measurements and found that there is a rough consensus on level of independence level of each central bank in developed countries. Then, with these different CBI indexes, we reexamined the relationship between CBI and the level and variance of inflation rates (or M1 growth rates). With the sample of developed countries, the estimation results confirmed the previous studies which argued that CBI has a negative effect on inflation rates. However, we found that this inverse relationship between CBI and inflation rates disappeared in developing countries after we exclude four hyper-inflation countries from the sample of developing countries. This implies that the previous studies might be biased by these hyper-inflation countries since these countries have very dependent central bank systems.

As the most important factor we did not find the inverse relationship in developing countries, we argue that, in these countries, the level of CBI is too low to have an impact on the economy. This is supported by the existence of much bigger gaps between fitted and actual inflation rates in these countries than in developed countries. This gives an important implication to the countries which are going to reform their central bank system. It says that, if a country has a highly dependent central bank, slight improvement of CBI would not be helpful in achieving low inflation and so they may need much greater reform in the central bank system.

The similar implication comes from the estimation of the relationship between the variables for CBI and inflation. The estimation results imply that real improvement of CBI comes from reforming policy variables which are directly related with actual monetary policy, not from reforming formal variables like literal objectives of the central bank. In summary, this chapter suggests the countries which are going to make their central bank more independent need to make more rapid and greater reform in the central bank system, especially, in policy variables among many factors regarding CBI in order to get the effects they want from the reform.

CHAPTER III

CENTRAL BANK INDEPENDENCE AND LIQUIDITY EFFECTS

In this chapter, we examine the possibility that the degree of monetary policy effect on economy could differ across countries among which central banks have different levels of independence. In order to measure the monetary policy effect, we estimate the liquidity effect which is a short-run negative response of interest rates to an increase in the money supply.

To examine the relationship between CBI and liquidity effects, first, we set a model economy which produces liquidity effects and investigate the effect of CBI on the liquidity effects in the model. Then, we apply empirical approaches to estimate the relationship between CBI and liquidity effects by adopting three different traditional approaches and seemingly unrelated regression (SURE) method. We model only developed countries to explore the possible relationship between CBI and liquidity effects since the results of previous chapter suggest the possibility that CBI has little effect on economic variables in developing countries.

To estimate the liquidity effects, we concentrate on the relationship between a money aggregate, M1, and the money market interest rate in 12 OECD countries.²² For CBI index, we use the legal independence index suggested by Cukierman (1992). We use money market interest rates which are consistent with those used in most previous studies. These interest rates for 12 countries come from IFS series number 60B in each

²² We estimate the relationship with alternative money aggregate, total reserves and monetary base, in the end of the first section.

country section. This is the federal funds rate in U.S. and the call rate in other countries. These rates are extremely short-term interest rates which allow us to separate liquidity effects from expected inflation effects without imposing a theory of the term structure and expected inflation. For the series on M1, we use IFS series number 34 which is the sum of currency outside banks plus demand deposits held with the monetary system by the rest of domestic economy other than central government. We use the monthly series for each variable.²³

We estimate the liquidity effect over 1970's with a sample of countries for which data are available and over 1980 to 1994 period with all 12 countries as well as over the full 1971 to 1994 period. The sample countries are Australia ('69.7), Canada ('75.1), Denmark ('74.1), Finland ('77.1), France ('64.1), Germany ('64.1), Italy ('71.1), Netherlands ('60.1), Norway ('71.8), Sweden ('66.1), U.K ('72.1) and U.S ('57.1). The month in parenthesis indicates the first month when data are available in each country. For Germany, we will consider only West Germany before unification in 1990 to avoid effects of the large economic shocks on some economic variables after unification.

1. Model Approach

1-1. Basic Liquidity Model

²³ Geweke and Runkle(1995) suggest that time aggregation from a biweekly interval to a quarterly interval is not a problem when identifying monetary policy and that time aggregation does not seem to be a problem when evaluating the dynamic effects of typical changes in variables.

We consider a basic liquidity model in Christiano and Eichenbaum (1992b) which is a simplified version of the model in Christiano (1991). The following argument for the model mainly comes from Christiano and Eichenbaum (1992b). In basic liquidity model, the only source of uncertainty in the agents' environment pertains to monetary policy. The model has three types of agents: households, goods-producing firms, and financial intermediaries. At the start of period t , the representative household possesses the economy's entire beginning-of-period money stock M_t . The household allocates Q_t dollars to purchases of the consumption good, C_t , and lends the rest, $M_t - Q_t$, to financial intermediaries. Consumption purchases must be fully financed with cash that comes from two sources: Q_t and current-period wage earnings. The household chooses Q_t , C_t , and the fraction of period t devoted to work (L_t) to maximize the expected value of the criterion $\sum_{t=0}^{\infty} \beta^t U(C_t, 1 - L_t)$. Here $U(C_t, 1 - L_t)$ denotes the household's utility function, given by $(1 - \gamma)\ln(C_t) + \gamma\ln(1 - L_t)$. Also, β and γ are scalars between 0 and 1.

In the basic liquidity model, the household's contingency plan for Q_t is not a function of the period- t realization of monetary policy. The maximization occurs subject to the cash constraint that nominal consumption expenditures, $P_t C_t$, can not exceed Q_t plus $W_t L_t$. Here P_t and W_t denote the period- t dollar price of goods and labor, respectively. In addition, the household must obey its budget constraint,

$$M_{t+1} = R_t (M_t - Q_t) + D_t + F_t + (Q_t + W_t L_t - P_t C_t)$$

where R_t is the gross interest rate in period t and F_t and D_t denote period- t dividends received from firms and financial intermediaries respectively.

The financial intermediary has two sources of funds: $M_t - Q_t$ and lump-sum injections X_t of cash by the monetary authority. These funds are lent over the period in perfectly competitive markets to firms at the gross interest rate R_t . The financial intermediary's net cash position at the end of the period is distributed, in the form of dividends, to the financial intermediary's owner, the household, after the consumption-good market has closed.

The period- t technology for producing new goods is given by

$$f(K_t, z_t L_t) = K_t^\alpha (z_t L_t)^{1-\alpha} + (1-\delta)K_t \quad \text{for } 0 < \alpha < 1 \text{ and } 0 < \delta < 1.$$

Here K_t is the beginning-of-period- t stock of capital, δ is the rate of depreciation on capital, and the function $f(\cdot, \cdot)$ denotes new period- t output plus the undepreciated part of capital. Also, z_t is the state of technology at period t , which grows at the constant geometric rate $\mu > 0$. Firms must borrow working capital $W_t L_t$ from financial intermediaries to cover their labor costs. Loans must be repaid to the financial intermediaries at the end of period t . Consequently, the total period- t cost associated with hiring labor equals $R_t W_t L_t$.

Firms own the stock of capital, which evolves according to $I_t = K_{t+1} - (1 - \delta) K_t$, where I_t denotes period- t gross investment. Unlike labor, capital is assumed to be a credit good, so that the firm need not borrow funds from the financial intermediary to finance investment activities. At the end of the period, after consumption-good market closes, the firm's net cash position is distributed to its owner, the household. The perfectly competitive firm maximizes the expected present discounted value of dividends by choice of contingency plans which satisfy I_t and L_t as functions of model variables dated period t and earlier.

The shock in the model economy is disturbance to the rate of growth of money, x_t . Here, $x_t \equiv X_t / M_t$, where X_t , again, is cash injections from the monetary authority to the financial intermediaries and $M_{t+1} = M_t + X_t$. We assume that the shock enters this way :

$$x_t = (1 - \rho_x) \bar{x} + \rho_x x_{t-1} + \varepsilon_{x,t}.$$

The shock to money growth, $\varepsilon_{x,t}$, is mutually uncorrelated at all leads and lags and are uncorrelated with x_{t-j} , $j > 0$. It is the part of x_t that can not be predicted based on past values of the variables in the model. For this reason, $\varepsilon_{x,t}$ is referred to as the unexpected components of x_t . The parameter ρ_x in equation controls the autocorrelation properties of x_t . In particular, the correlation between x_t and x_{t-j} is just ρ_x^j for $j > 0$. Finally, $\bar{x}$ is the unconditional mean of x_t .

1-2. Generating a Liquidity Effect

The key feature of the basic liquidity model which lets it generate a substantial liquidity effect is that the assumed rigidity in Q_t prevents an increase in the money supply from being distributed proportionally among all agents. If Q_t does not respond to X_t , a positive money shock increases the total percentage of the money supply available to financial intermediaries to lend to firms. However, this requires that firms absorb a disproportionately large share of new cash injections. For firms to do so voluntarily, interest rates must fall. Of course, if the growth rate of money displays positive persistence, then the expected inflation effects of a change in the growth rate of money exert countervailing pressure on interest rates. Under these circumstances, whether interest rates fall or rise depends on which effect is stronger.

1-3. CBI in Basic Liquidity Model

The theoretical argument for CBI is based on the view that political policy-makers are subject to an inflationary bias. Monetary policy enables them quickly, but temporarily to achieve various real objectives such as high employment or low interest rates. In the process, high-powered money is increased fueling inflation and inflationary expectations and creating an inflationary bias that persists long after the desirable effects of monetary expansion have disappeared. The inflationary policy bias can be eliminated by precommitting policy prior to contracting time to price stability or to a low rate of inflation. One way of implementing this commitment in practice is to give sufficient independence to the central bank and to direct it by law and/or other means to focus on price stability even if that implies a relative neglect of other objectives.

Therefore, the central banks would show different characteristics in their monetary policies depending on the levels of their own independence. This implies that the time path of money growth rate also might be affected by CBI. We assumed the money growth rule as follows in the model : $x_t = (1 - \rho_x) \bar{x} + \rho_x x_{t-1} + \varepsilon_{x,t}$.

Now, consider how this growth path would be changed by difference in levels of CBI. First, $\bar{x}$ is the unconditional mean of x_t . From the previous chapter, we know that low CBI countries have experienced higher average growth rate of money than high CBI countries, that is, $\bar{x}$ would be greater in low CBI countries than in high CBI countries. The country which has higher $\bar{x}$ value should have experienced higher inflation rate. Therefore, higher $\bar{x}$ value leads to stronger expected inflation effect in the country and so, as Christiano and Eichenbaum (1992) mentioned, this strong expected inflation effect

would make interest rates fall less given monetary expansion in the model. However, this does not mean that high CBI has a positive effect on monetary policy in this model since ρ_x also could be affected by CBI.

In monetary policy rule above, ρ_x controls the autocorrelation properties of x_t and determines the dynamic characteristics of time path of money growth rate since it represents the persistency of money shock in the model economy. High value of ρ_x means that money shock is much more persistent in the economy. Here, we need to examine why inflation is persistent.

Cukierman (1992) accounts for the persistence by linking the central bank's current actions to the public's expectations about the future. Current inflation provides information to the public, either about the central banker's type or about the central bank's private information about serially correlated aggregate supply shocks. Therefore, high inflation today raises expected inflation next period as the public infers that the central bank is soft on money growth in the first case or because the public infers that a persistent aggregate supply shock has raised the marginal benefit of inflation in the second case. The rise in expected inflation in the following period also raises the actual rate of inflation for that period. Thus, persistence arises because of learning considerations, not because of wage and price rigidities in the economy. Cukierman (1992)'s models imply that inflation's persistence is due fundamentally to the persistence properties of the shock, not the policy response.²⁴ If all shocks are transitory, so is inflation, or if the public shares the same information as the central bank, inflation's persistence is exactly that of the shock. Cukierman (1992) and Ball (1990) also argue

that central bank preference has an important role in explaining the persistence of inflation.

Since the only shock in our model economy is a monetary shock and inflation history of a country has been affected by the level of CBI of the country, Cukierman's argument gives us an empirical implication that persistence of money shock in the model could be different if the country has the different levels of CBI. Low CBI countries have shown more persistent inflation history and their inflation rates have been increasing for last couple of decades. In a simple model in which only shock in the economy is monetary shock, inflation persistence is due to the persistence properties of the monetary shock. Therefore, we infer that persistence of monetary shock is stronger in low CBI countries even though there are other factors which affects inflation persistence.

To examine the relationship between CBI and persistence of money shock in real economy, we follow the estimation method in Christiano (1991), and Christiano and Eichenbaum (1992). We make first-order autoregressive models for each country in our sample and estimate the coefficient ρ_x of each country for 1970-1994. Then we regress CBI on the value of ρ_x . Our estimated result is as follows;

$$\rho_x = 0.427 - 0.337 \text{ CBI} \quad R^2 = 0.65 \\ (-2.36)$$

and the coefficient of CBI is significant at 10 per cent level.

This estimation confirms the preceding argument that low CBI countries have had more persistent money growth shock during last couple of decades. This might be explained by the facts that in low CBI countries, money growth rate has been increasing and the

²⁴ See Chapters 9 -16 in Cukierman (1992).

government in these countries might have strongly affected the conduct of monetary policy by affecting institutional structure or preference of the central bank.

Now consider how persistence in money shock affects the liquidity effect in the model. A money shock increases not just x_t , but also x_{t+j} for $j>0$. And the change in x_{t+j} would increase when ρ_x approaches to 1. The unexpected upward revision in the forecast of x_{t+1} exerts upward pressure on P_{t+1}/P_t , that is, a persistent jump in money growth raises anticipated inflation. The more persistence in money growth shock would result in the higher anticipated inflation. Therefore, this higher anticipated inflation exerts more countervailing pressure on interest rates. Under these circumstances, interest rates might fall less or even might rise by stronger expected inflation effects. Christiano (1991) shows the quantitative results that high value of ρ_x decreases the liquidity effect in the model economy.²⁵

The last element to examine is $\varepsilon_{x,t}$ in money growth rule. In previous chapter, we did not find any relationship between Cukierman's index for CBI and the variance of money growth rate while we found a relationship between Alesina and Summers' index and the variance of money growth rate. The variance of money growth rate is greater in low CBI countries than in high CBI countries when we use Alesina and Summers' index for CBI. However, this does not mean that the variance in money growth rule in our model, $\sigma_{\varepsilon,x}$, also has a relationship with CBI because we control the autocorrelation properties of money growth rate in the model. $\varepsilon_{x,t}$ is the unexpected component of x_t that can not be predicted based on past values of variables in the model. The size of $\varepsilon_{x,t}$ depends on monetary policy authorities' decision or economic circumstances at each time and so does

the variance, $\sigma_{\varepsilon, x}$. Policy authorities decide the money growth rate after they consider all available economic and political information. Therefore, the size of $\varepsilon_{x,t}$ is determined when they set the money growth rate at each time and is independent of degree of persistence in money growth rate rule. If large variance of money growth rate results mainly from strong persistence of shock in money growth rate, the variance of money growth rate would have little relationship with the variance in our model, $\sigma_{\varepsilon, x}$. If the variance of money growth rate comes mainly from other sources, the variance in our model could have a relationship with the variance of money growth rate and also could have a relationship with CBI, particularly, Alesina and Summers' index. However, in developed countries in our sample for 1970-1994, we do not find any relationship either between the variance of money growth rate and the variance in our model or between CBI and the variance in our model, $\sigma_{\varepsilon, x}$, no matter which CBI index is used. These results suggest that $\sigma_{\varepsilon, x}$ can be considered as a parameter which is independent of CBI.

In summary, level of CBI affects the money growth rule in the basic liquidity model we examined. The lower CBI results in higher average money growth rate (high x) and more persistence (high ρ_x) of money growth shock. High average money growth rate and/or more persistent money growth shock raises anticipated inflation. This stronger expected inflation effect might dominate liquidity effect or at least lessen the liquidity effect of a given expansionary money shock. Therefore, in the basic liquidity model, low CBI results in weak monetary policy effect, that is, weak liquidity effect as we assumed at the beginning of the paper.

²⁵ See the Table 2 in page 19 in Christiano (1991).

2. Traditional Empirical Approaches

In this section we use three different traditional methods to estimate liquidity effects. The traditional analysis of the liquidity effects is firmly rooted in the comparative statics of money demand: An increase in the rate of growth of the money supply, holding output and prices constant, causes the nominal interest rate to fall. After an increase in money growth there will be a period over which the interest rate is depressed. Eventually, inflation will adjust to the new money growth rate and the long-run correlation between the interest rate and money growth is positive. The long-run tendency for changes in money growth to be reflected in expected inflation and thus, nominal interest rates, is referred to as the expected inflation effect. The negative interest elasticity of money demand produces the liquidity effect, but ultimately the expected inflation effect dominates the liquidity effect.

There are two traditional empirical approaches to estimate the liquidity effect. One is the reduced-form approach which calculates reduced-form correlations between interest rate and money aggregate and the other is the aggregate money demand approach which estimates a money demand equation. The reduced-form approach regresses interest rate against current and past monetary aggregate. The aggregate money demand approach estimates the interest elasticity that underlies the liquidity effect by conditioning on a broader set of variables and imposing more restrictive assumptions on dynamics than does the reduced-form approach. In this paper, we replicate the reduced-form approach to estimate the liquidity effect and examine the relationship between CBI and liquidity

effect. In addition to the reduced-form approach, we also use dynamic correlation method following Christiano and Eichenbaum (1992).

However, although the traditional approaches give us clear methodologies for seeking liquidity effects, these approaches assume that the money supply is exogenous. When the variation in money supply is not independent of money demand, these empirical results do not distinguish how much of the money-interest correlation is due to interest elasticity of money demand and how much of the correlation arises from the dependence of money supply and interest rates on other variables. Furthermore, as Leeper and Gordon (1992) argued, few economists would disagree that the traditional approaches correctly characterizes the economy's short-run response to an exogenous monetary shock and there is considerably less agreement on how to identify such shocks empirically. Therefore, in order to compensate these deficiencies, in next chapter, we will try to identify money supply shock with vector autoregression (VAR) approaches.

2-1. Traditional Distributed Lag Regressions.

The traditional empirical approach to measuring the liquidity effect, which is associated with Cagan and Gandolfi (1969), Melvin (1983) and Cochrane (1989), regresses interest rates against current and past growth of a monetary aggregate.

$$r_t = \alpha + \beta(L)\rho_t + \varepsilon_t$$

$$\text{where } \beta(L) = \sum_{j=0}^n \beta_j L^j \quad (2.1)$$

r_t = level of interest rate

ρ_t = growth rate of money

If it is found that the cumulative coefficients from this regression are significantly negative over some relatively short horizon, it is interpreted as evidence that the liquidity effect dominates the relationship between money growth and interest rates in the short run. Since these regressions condition only on money growth rates, to interpret the coefficients as reflecting the effects of monetary policy on interest rates we must assume that money growth and interest rates do not have a strong tendency to respond jointly to other variables. To investigate the relationship between money growth and the interest rate, we will use the following lag lengths for each period : 1971.1~1979.12 (18 lags), 1980.1~1994.12 (24 lags), 1971.1~1994.12 (36 lags). In choosing lag lengths for the regressions, usually there exists a trade-off between including enough lags to exhaust the information in the data and overfitting the data. Here, we use the lag lengths which are consistent with those used in previous studies.²⁶

2-2. Dynamic Multipliers Methods

These distributed lag regressions have been largely supplemented by estimates of dynamic multipliers associated with unanticipated changes in money growth. To obtain the dynamic multipliers implied by traditional regressions, we append to the interest rate

equation describing the evolution of money growth, which allows the data to characterize money innovations. A money innovation is defined as a one-time change in the residual of the money equation and the two equations are used to trace out the paths of money growth and interest rates associated with a typical money innovation. Here, we maintain the assumption that money growth is exogenous and estimate a univariate autoregressive process for it.

$$\rho_t = \delta_0 + \delta(L)\rho_t + \eta_t \quad (2.2)$$

$$\text{where } \delta(L) = \sum_{i=1}^n \delta_i L^i$$

Combining (2.1) and (2.2) yields the multipliers $\gamma(L)$ in

$$r_t = \alpha' + \gamma(L)\eta_t + \varepsilon_t \quad (2.3)$$

$$\text{where } \alpha' \equiv \alpha + \beta(1) [1 - \delta(1)]^{-1} \delta_0$$

$$\gamma(L) \equiv \beta(L) [1 - \delta(L)]^{-1}$$

To estimate liquidity effect, we examine the path of the interest rates for 36 months following a one-percentage point innovation to the growth rate of the money. (that is, we set $\eta_t = 1$, and $\eta_{t+k} = 0$ for $k \neq 0$)

2-3. Dynamic Correlations

In addition to the previous reduced-form approaches, we estimate the liquidity effect by investigating dynamic correlations between the variables. Following Christiano and

²⁶ Leeper and Gordon (1992) summarize the previous studies which used traditional distributed lag regressions to get the liquidity effects.

Eichenbaum (1992), we get liquidity effects through dynamic correlations between interest rate at time t and money growth rate at time $t \pm \tau$. Here, we assume that money is positively correlated over time and consider a benchmark scenario in which the only shocks are those of the money supply. Christiano and Eichenbaum (1992) describes the scheme for dynamic correlation as follows:

“... Consider first the correlation between FF_t (Federal funds rate) and future values of M_t (money). Suppose that, at time t , there was an unanticipated increase in the money supply. Given a liquidity effect, this would be associated with a decline in FF_t . With M_t positively correlated over time, high values of M_t would be associated with high values of $M_{t+\tau}$, for $\tau > 0$. Other things being equal, we would expect FF_t to be negatively correlated with future values of M_t with the exact magnitude of the correlation depending on the size of the liquidity effect and the degree of serial correlation in M_t .

Next consider the correlation between FF_t and past values of M_t . Suppose that at time $t-\tau$, for $\tau > 0$, there was an unanticipated increase in money supply. This would exert negative pressure on $FF_{t-\tau}$. Suppose that M_t is sufficiently autocorrelated that the initial increase in $M_{t-\tau}$ is associated with higher growth rates in $M_{t-\tau+j}$ for $j \geq 1$. This, we expect, would generate an increase in the anticipated rate of inflation from time $t-\tau+j$, for $j \geq 1$. If the liquidity effect lasted only one period, then the inflation effect would dominate after one period, so that $FF_{t-\tau+j}$, for $j \geq 1$ would rise. Consequently, $FF_{t-\tau+j}$, for $j \geq 1$, would be positively correlated with $M_{t-\tau}$, that is, $\rho(FF_t, M_{t-\tau}) > 0$ for $\tau \geq 1$, where $\rho(\cdot, \cdot)$ denotes the correlation operator. In fact, there is no reason to believe that the liquidity effect lasts for only one period. Suppose instead that liquidity effect dominated the expected inflation effect for k periods. Then $\rho(FF_t, M_{t-\tau})$ would be negative for $\tau \leq k$, but positive for $\tau > k$. In this sense, k can be thought as measuring the persistence of the liquidity effect.

While useful for pedagogical purposes, the logic of the previous scenario holds only if the sole source of aggregate uncertainty is shocks to the money supply. With other shocks to the system, the dynamic correlation between FF and the stock of money depends, at least in part, on the way the FOMC reacts to the other shocks. ...” (p.343)

Here, we will get the dynamic correlation, $\rho(i_t, M_{t-\tau})$, for $-18 \leq \tau \leq 18$ (1971.1~1979.12), $-24 \leq \tau \leq 24$ (1980.1~1994.12) and $-36 \leq \tau \leq 36$ (1971.1~1994.12). The choice of value of τ , the lengths of leads and lags, is consistent with the choice of the lag length in the previous reduced-form approaches. Furthermore, we will calculate the value of k to measure the persistency of the liquidity effect for each period.

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2-4. Estimation Results

With the equation (2.1), we get a response path of interest rates given monetary shock. Figure 5 depicts the cumulative lag coefficients, the sum of β_j 's in equation (2.1), on the growth rate of M1. In high CBI countries, the cumulative coefficients are consistently significantly negative for over more than two years. This implies there exists persistent and strong liquidity effects in high CBI countries. Liquidity effects are strong enough to dominate the expected inflation effects for the two year time span in the high CBI countries. Liquidity effects, however, seem to be dominated by expected inflation effects in the low CBI countries. The responses of interest rates in the low CBI countries show little negative relationship with the monetary shock and in a short period of time after monetary shock, interest rates begin to increase because of the expected inflation effects.

To examine the relationship between CBI and liquidity effects, we pick the value of contemporary liquidity effect (β_0) and minimum value of liquidity effect (value of the $\sum \beta_i$ which reaches the minimum point in the given time span) for each country. In addition, we calculate average liquidity effect which represents response of interest rates on average during the periods of time we examine. This number would be positive if, on average, expected inflation effects are stronger than liquidity effects in the given time span. A negative sign would imply that an expansionary monetary shock, on average, decreases interest rates through a liquidity effect rather than increasing interest rates through expected inflation effects during those periods. After computing these values, we regress each of these values on the CBI index. The results are reported in Table 12.

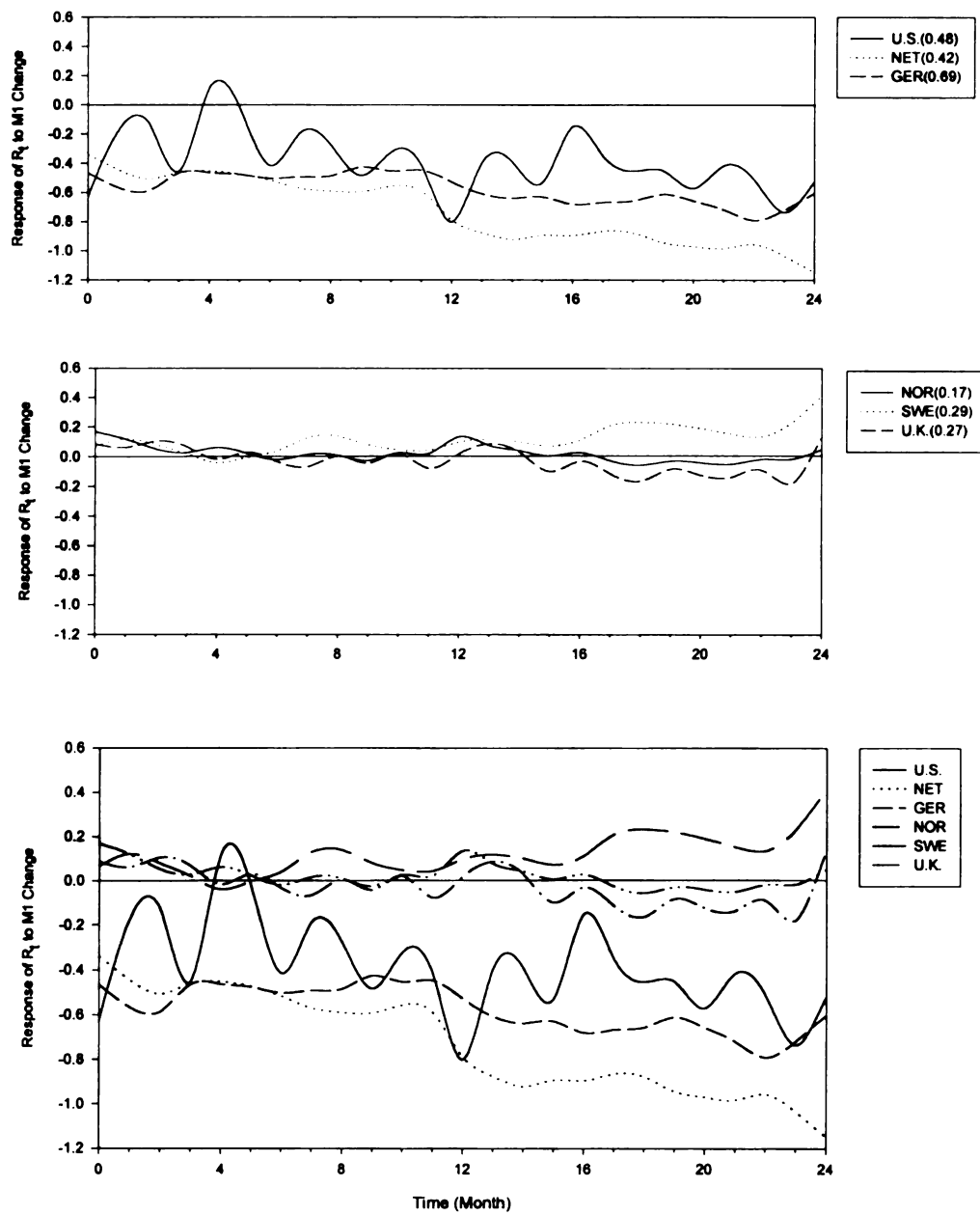


Figure 5. Response of R to $M1$ Change (1980~1994: Eq.(2.1))

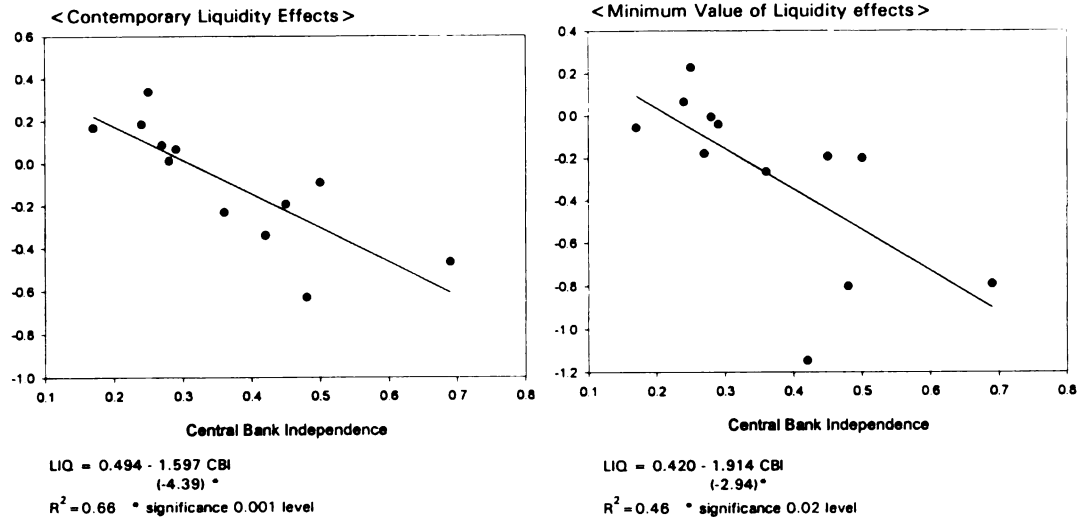
Table 12. CBI and Liquidity Effects (Eq.2.1)

Dependent Variables	Explanatory Variables	1970-1979	1980-1994	1970-1994
Contemporary Liquidity Effect	Intercept	0.029	0.494	0.122
	CBI	-1.074*	-1.597****	-0.807****
	R ²	(-1.80)	(-4.39)	(-3.18)
Minimum Value of Liquidity Effect	Intercept	0.029	0.420	0.009
	CBI	-1.409***	-1.914***	-0.896**
	R ²	(-2.96)	(-2.94)	(-2.40)
Average Liquidity Effect	Intercept	0.143	0.481	0.117
	CBI	-0.700	-1.597****	-0.691*
	R ²	(-1.20)	(-3.36)	(-2.18)
		0.17	0.53	0.32

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 5 percent level, *** at 3 percent level, and **** at 1 percent level.

The results confirm our hypothesis that CBI level influences the liquidity effect. The greater CBI, the stronger liquidity effects. Contemporary responses of the interest rate to monetary shocks are larger in the high CBI countries than in the low CBI countries in every sample period. In particular, the inverse relationship between CBI and the contemporary liquidity effect is significant at 1 percent level for both 1980-1994 and 1970-1994 periods. The minimum value of the liquidity effect also seems to have an inverse relationship with CBI. For the periods of 1970-1979 and 1980-1994, this inverse relationship is significant at the 3 percent level, and at the 5 percent level for 1970-1994 period. This implies that the response of interest rates to monetary disturbances is stronger in high CBI countries than in low CBI countries. Figure 6 clearly shows these relationships for some sample periods.

1. 1980 - 1994



2. 1970 - 1994

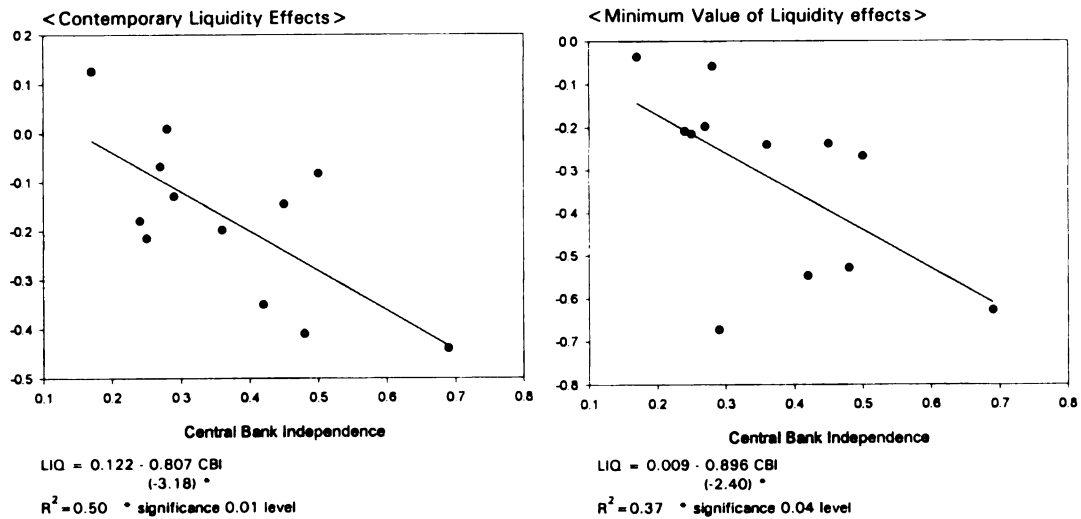


Figure 6. CBI and Liquidity Effects (M1, Eq.(2.1))

The average liquidity effect is also significantly affected by CBI. For all three sample periods, we find an inverse relationship between CBI and the average liquidity effect although the relationship is not significant for 1970-1979 period. These regression results, therefore, suggest that the overall response of interest rates to monetary shock would be deeper and greater in high CBI countries than in low CBI countries and confirms our expectation at the beginning of the paper about the response path of interest rates to a monetary shock.

We can draw the same conclusion from other traditional methods. Allowing money growth to evolve according to its own past does not appreciably alter the characterization drawn by the cumulative coefficients in the previous approach. In high CBI countries, monetary innovations have a negative contemporaneous correlation with the interest rate for all periods. Figures 7 shows response paths of interest rates given monetary shock at time 0 for some countries during 1980-1994 period. In the figure, the point estimate shows that the interest rate declines at impact and stays below its initial level for about two years in high CBI countries like United States or Netherlands. However, in low CBI countries, monetary innovations seem to have even a positive contemporaneous correlation with the interest rate and interest rate maintains almost the initial level despite of a monetary shock given at the initial time. This confirms that high CBI countries have a stronger and more persistent liquidity effect than low CBI countries. To investigate the relationship between CBI and the liquidity effect, we pick the values of contemporary and minimum liquidity effect for each country from the values of correlation between monetary innovation and the interest rate and estimate the relationship between these variables and CBI. We also calculate average value of responses in interest rate. The

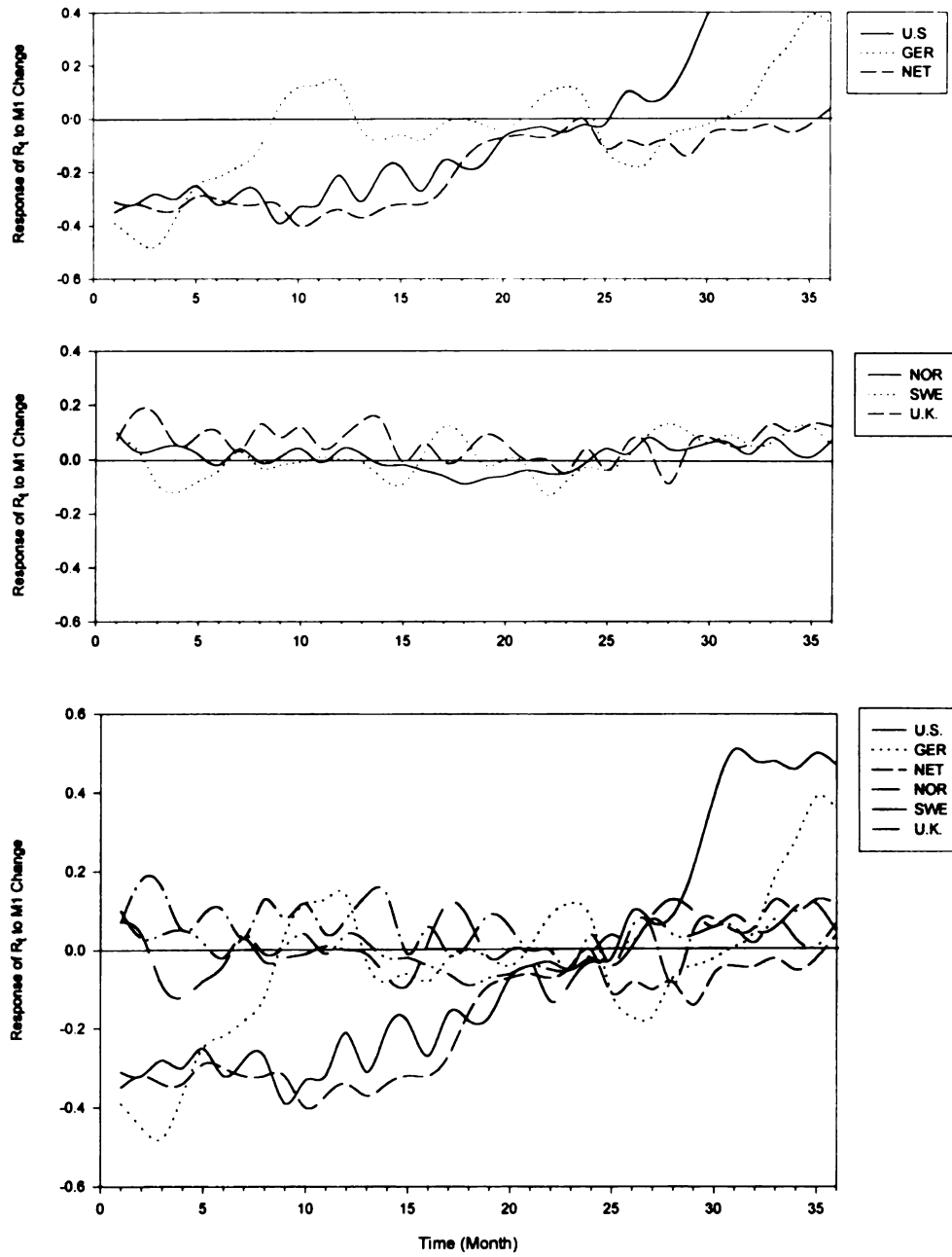


Figure 7. Response of R to M1 Change (1980~1994, Eq.(2.3))

regression results confirm our previous result which shows inverse relationship between liquidity effects and CBI. The estimation results are reported in table 13 and Figure 8 depicts these relationships for some sample periods.

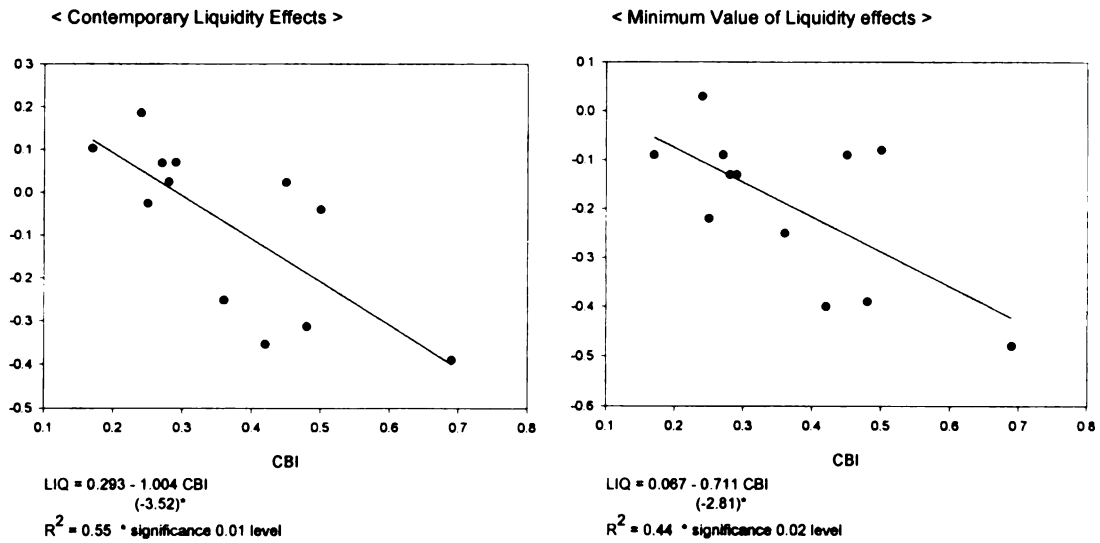
The relationships between CBI and liquidity effects which are derived by monetary innovation equation (2.3) satisfy our expectations. All but one sign of coefficients are the same as we expected and the results coincide with the previous one in which we used equation (2.1) to derive liquidity effects. Both the contemporary liquidity effect and the minimum value of liquidity effect are significantly affected by CBI for all 3 different sample periods, but the relationship between CBI and the average liquidity effect is significant only for 1970-1994 period.

Table 13. CBI and Liquidity Effects (Eq.2.3)

Dependent Variables	Explanatory Variables	1970-1979	1980-1994	1970-1994
Contemporary Liquidity Effect	Intercept	0.049	0.282	0.281
	CBI	-1.479** (-2.61)	-0.846**** (-3.03)	-1.174**** (-4.48)
	R ²	0.49	0.48	0.67
Minimum Value of Liquidity Effect	Intercept	-0.176	0.063	0.050
	CBI	-1.132* (-1.82)	-0.712*** (-2.69)	-0.894*** (-2.84)
	R ²	0.32	0.42	0.45
Average Liquidity Effect	Intercept	-0.066	0.198	0.044
	CBI	0.512 (0.56)	-0.467 (-1.68)	-0.262*** (-2.51)
	R ²	0.04	0.22	0.39

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 5 percent level, *** at 3 percent level, and **** at 1 percent level.

1. 1980 - 1994



2. 1970-1994

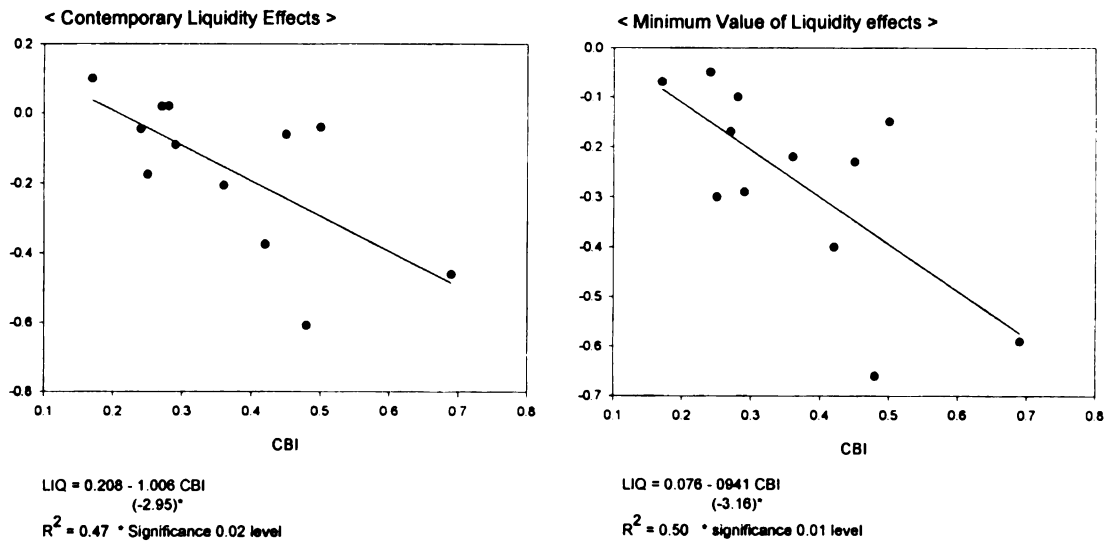


Figure 8. CBI and Liquidity Effects (M1, Eq.(2.3))

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Finally, Using the dynamic correlation method to estimate the liquidity effect still does not change our conclusion about the relationship between CBI and the liquidity effect. From Figure 9, we can find easily that liquidity effects persist up to 3 years in Germany and more than 2 years in other high CBI countries. In low CBI countries, however, the figure shows that the persistence of liquidity effects is very weak.

To examine the effect of CBI on the liquidity effect, we use the same kind of values as we did in the previous traditional methods. We pick up the contemporary and minimum values of dynamic correlation and also calculate the average value of the liquidity effect given time span. In addition, we test the persistency of liquidity effects by using k in Christiano and Eichenbaum's argument which is the number of months which show liquidity effects, in dynamic correlation method. We regress CBI on these values and estimate the relationship. Figure 10 depicts the relationship for the sample period of 1980-1994 and Table 14 reports the regression result.

When we use the dynamic correlation method to estimate the liquidity effect, we do not find any significant result for 1970-1979 period, though all coefficients have the signs we expected. On the other hand, the estimated results for 1980-1994 period are all significant at 1 percent level. CBI has especially strong positive effect on the persistence of the liquidity effect at 1 percent significance level during the sample period. The result suggests improving CBI by 0.1 would increase the liquidity effects by 7 months.

In summary, the estimation results support our hypothesis that there exists an inverse relationship between CBI and the liquidity effect no matter which traditional method we use. In high CBI countries, responses of interest rates given monetary shocks are stronger and deeper than those of low CBI countries. Interest rates are more sensitive to monetary

innovation and the persistence of liquidity effects is stronger in high CBI countries than in low CBI countries. These results, therefore, imply monetary policy effects on economy may be greater in high CBI countries than low CBI countries.

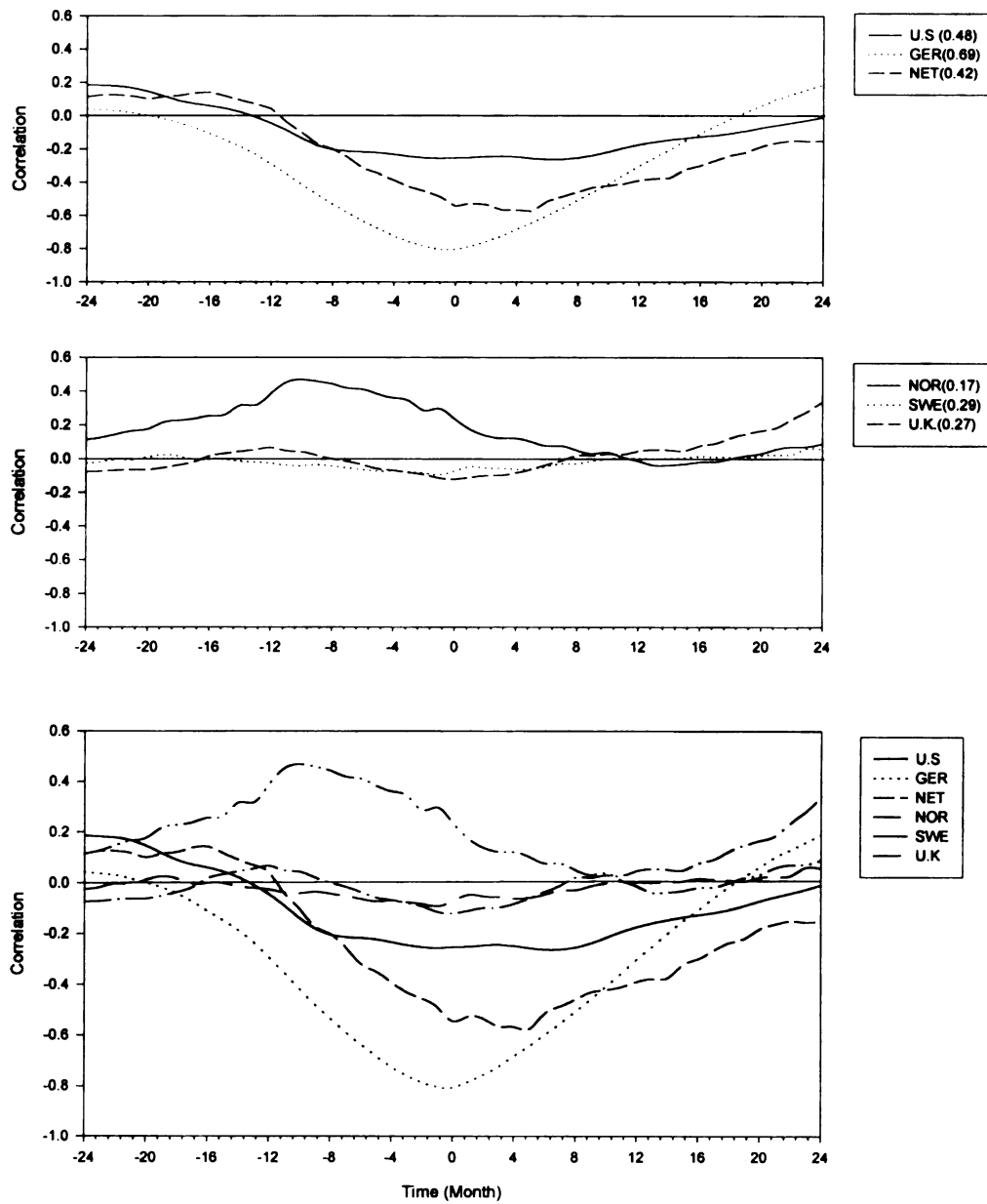


Figure 9. Dynamic Correlations b/w R_t and $M1_{t-\tau}$ (1980~1994)

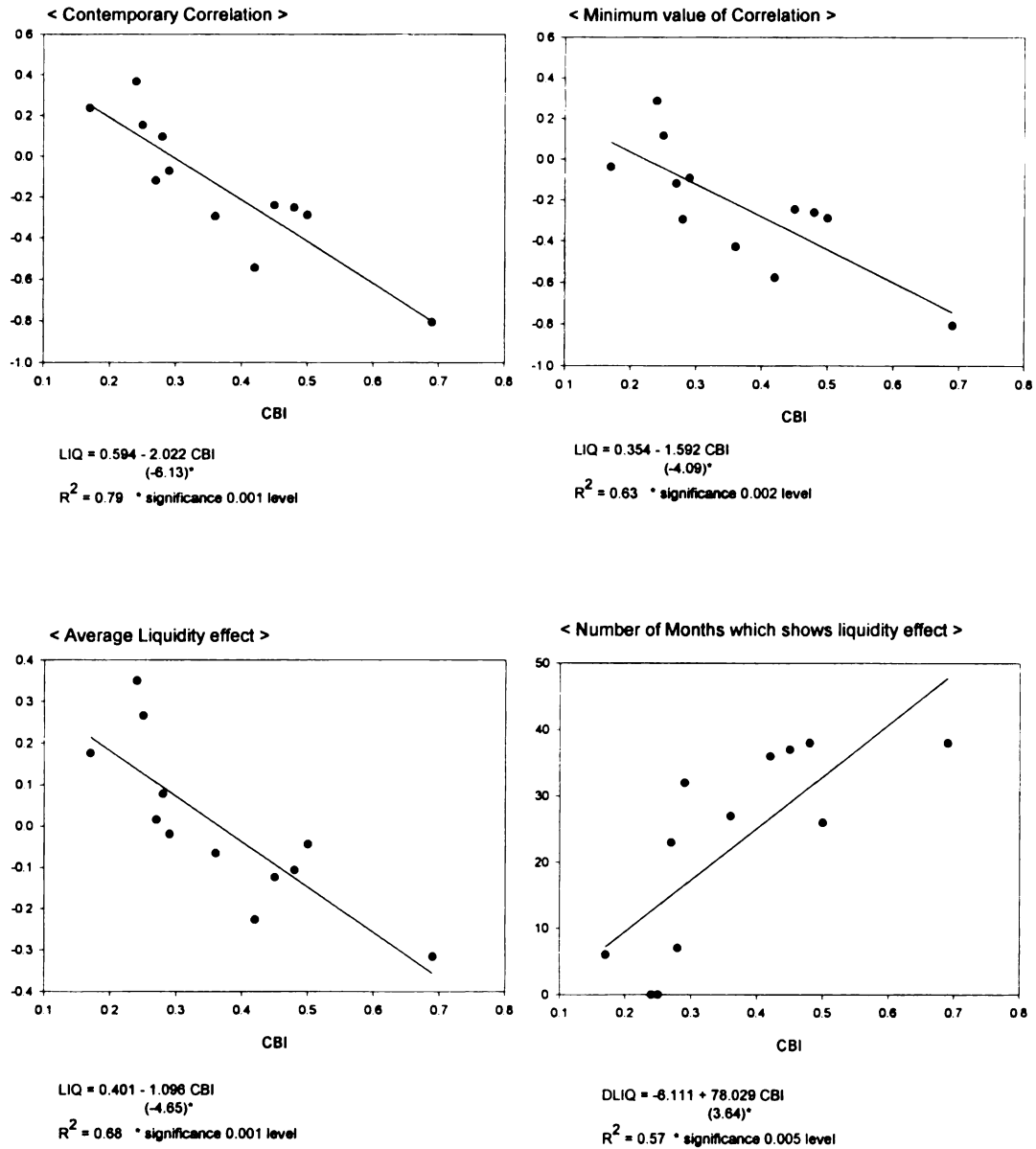


Figure 10. CBI and Liquidity Effects (M1, 1980~1994: Dynamic Corr.)

Table 14. CBI and Liquidity Effects (Dynamic correlation)

Dependent Variables	Explanatory Variables	1970-1979	1980-1994	1970-1994
Contemporary Liquidity Effect	Intercept	0.154	0.594	0.335
	CBI	-0.992 (-1.71)	-2.022** (-6.13)	-1.358** (-3.73)
	R ²	0.30	0.79	0.58
Minimum Value of Liquidity Effect	Intercept	-0.229	0.354	0.036
	CBI	-0.469 (-1.13)	-1.592** (-4.09)	-0.846* (-2.18)
	R ²	0.15	0.63	0.32
Average Liquidity Effect	Intercept	0.018	0.401	0.129
	CBI	-0.111 (-0.63)	-1.096** (-4.65)	-0.309 (-1.72)
	R ²	0.05	0.68	0.23
Persistency of Liquidity Effect	Intercept	12.960	-6.111	18.519
	CBI	14.310 (1.09)	78.029** (3.64)	37.447 (0.98)
	R ²	0.15	0.57	0.09

Note : The t-statistics are reported in parentheses. * indicates significance at the 5 percent level, ** at 1 percent level.

2-5. Estimation with the Alternative Money Aggregates

In previous sections, to estimate the liquidity effects, we investigated the relationship between a money aggregate, M1, and the market interest rates. Although the estimation results show the inverse relationship between these liquidity effects and CBI, since there are alternative money aggregates which can be used to estimate the liquidity effects, there is a possibility that the liquidity effects from these alternative money aggregates have a different relationship with the CBI.

To investigate this possibility, we estimate the liquidity effects with other money aggregate, total reserves(TR) and monetary base(MB), by applying three different traditional approaches and then examine the relationship between these liquidity effects and CBI. We use IFS data series number 14 for TR and number 20 for MB.²⁷ We estimate the liquidity effects only for the periods of 1980-1994 because of data availability and the number of sample countries are 10 for TR liquidity effect and 11 for MB liquidity effect.²⁸

Using TR to estimate liquidity effect does not change our previous results. We do not find any significant difference in the relationship between CBI and TR liquidity effect from the relationship between CBI and M1 liquidity effect. Although the significance level is a little weaker, the TR liquidity effect has a negative correlation with CBI. Every

²⁷ IFS data series number 14 is the reserve money of monetary authority and number 20 comprises domestic currency holdings and deposits with the monetary authorities. These are somewhat different from exact amount of TR and MB in each country. We use them because they are calculated under the same criteria as well as they are available.

²⁸ We exclude Norway and U.K. for TR liquidity effect and U.K. for MB liquidity effect because data are non-available in these countries.

relationship meets our expectation no matter which methods are used to estimate the liquidity effect. Table 15 reports the estimation results with TR.

While the liquidity effect with TR has some significant relationships with CBI, the liquidity effect with MB does not have a significant relationship with CBI though all of the estimated signs of the coefficients are as we expected. However, we should not interpret this result as the evidence that makes our previous results less important. Since we use IFS data to get MB for each country because of data availability and this data is not the correct MB for every country because of difference in calculating MB, this estimation result might be less meaningful than others.

Although the significance of the inverse relationship between these liquidity effects and CBI are a little weaker than those when we use M1 for the estimation of liquidity effect, all estimated signs are exactly the same as we expected. Therefore, since generally it seems that the estimation results with alternative money aggregates support our previous results and M1 is the only money aggregate data which are available for whole our sample periods, we will concentrate only on M1 for the estimation of liquidity effect in next sections.

Table 15. CBI and Liquidity Effects (TR)

Dependent Variables	Explanatory Variables	EQ. 2.1	EQ. 2.3	Dynamic Correlation
Contemporary Liquidity Effect	Intercept	0.053	-0.010	0.418
	CBI	-0.141 (-1.13)	-0.014 (-0.10)	-1.026*** (-2.46)
	R ²	0.14	0.00	0.43
Minimum Value of Liquidity Effect	Intercept	0.095	-0.027	0.118
	CBI	-0.466* (-1.89)	-0.014 (-0.11)	-0.681 (-1.72)
	R ²	0.31	0.00	0.27
Average Liquidity Effect	Intercept	0.197	0.052	0.318
	CBI	-0.526** (-2.18)	-0.089 (-0.98)	-0.709** (-2.22)
	R ²	0.37	0.11	0.38
Persistency of Liquidity Effect	Intercept	-	-	-6.329
	CBI	-	-	79.87*** (2.60)
	R ²	-	-	0.46

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 6 percent level, *** at 4 percent level.

Table 16. CBI and Liquidity Effects (MB)

Dependent Variables	Explanatory Variables	EQ. 2.1	EQ. 2.3	Dynamic Correlation
Contemporary Liquidity Effect	Intercept	0.073	-0.009	0.332
	CBI	-0.272	-0.081	-1.017
		(-0.91)	(-0.30)	(-1.64)
	R ²	0.09	0.01	0.23
Minimum Value of Liquidity Effect	Intercept	0.159	-0.054	0.114
	CBI	-0.907	-0.091	-0.804
		(-1.35)	(-0.51)	(-1.73)
	R ²	0.17	0.03	0.25
Average Liquidity Effect	Intercept	0.362	0.085	0.238
	CBI	-0.975	-0.106	-0.620
		(-1.41)	(-0.55)	(-1.32)
	R ²	0.18	0.03	0.16
Persistency of Liquidity Effect	Intercept	-	-	5.618
	CBI	-	-	51.38
		-	-	(1.70)
	R ²	-	-	0.24

Note : The t-statistics are reported in parentheses.

3. Seemingly Unrelated Regression Approaches

3-1. SURE(Seemingly Unrelated Regression Estimation)

The previous section derived the liquidity effect by applying the same equation country-by-country, since we assume that the economic variables for each country are independent of those in the other countries. These equations, however, might be connected not because they interact, but because their error terms are related. For example, a shock affecting the interest rate for one country may spill over and affect the interest rate for other countries. In this case, estimating these equations as a set, using a single (large) regression, should improve efficiency and better reflect the real world. Actually, in the real world, there are many factors which affect the economies of all countries simultaneously. As a simple example, a change in world interest rates would affect the level of domestic interest rates in all countries, or supply side factors like an oil shock would spill over and change the price level of many countries at the same time. We, therefore, apply the SURE (Seemingly Unrelated Regression Estimation) to the previous equations and reestimate liquidity effects.

SURE consists of writing a set of individual equations as one giant equation. Suppose there are N equations $Y_i = X_i \beta_i + \varepsilon_i$, where the subscript i refers to the i^{th} equation.

These equations are written as

$$\begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} = \begin{bmatrix} X_1 & & 0 \\ & X_2 & \\ & & \ddots \\ 0 & & & X_n \end{bmatrix} \cdot \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

$$\text{or } Y^* = X^* \beta^* + \varepsilon^*.$$

If we allow contemporaneous correlation between the error terms across equations, so that, for example, the t^{th} error term in the i^{th} equation is correlated with the t^{th} error term in the j^{th} equation, the variance-covariance matrix of ε^* will not be diagonal. Estimating these error correlations and the diagonal elements (by using the residuals from each equation estimated separately) should allow estimation of the variance-covariance matrix of ε^* and generation of GLS estimated of β^* . Correlation of residuals are reported in Table 17. The values above the diagonal are correlations of the residuals from SURE and those below diagonal are the correlations of the residuals from OLS estimation for the period of 1980-1989.

From the table, for example, we observe that the residuals in equations of U.S and Germany or those of U.S and Canada are highly correlated and move together to the same direction. These high correlations raise the possibility that the variance-covariance matrix of ε^* is not diagonal. Breusch and Pagan (1980) suggest the Lagrange multiplier statistic to test whether the variance-covariance matrix of ε^* is diagonal.²⁹ Based on the OLS results, the Lagrange multiplier statistic is 145.79, with 66 degrees of freedom. The 1 percent critical value is about 100, so the hypothesis that the variance-covariance matrix of ε^* is diagonal can be rejected. Therefore, the estimation by SUR will give us more efficiency than the OLS estimation of the previous section.

²⁹ Following Breusch and Pagan (1980), we estimate the correlation coefficient between the i^{th} and j^{th} residuals from OLS. The sample size times the sum of all these squared estimated correlations is distributed as a chi-square with degrees of freedom equal to the number of correlations.

Table 17. Residual Correlation Matrix (1980-1989)

	U.S	GER	AUS	CAN	DEN	FRA	FIN	ITA	NET	NOR	SWE	U.K
U.S	1	0.608	-0.586	0.690	0.230	0.630	-0.269	0.448	0.367	-0.166	0.363	0.018
GER	0.374	1	-0.633	0.333	0.132	0.666	-0.558	0.258	0.331	-0.104	0.002	0.166
AUS	-0.479	-0.491	1	-0.107	-0.181	-0.655	0.481	-0.145	-0.350	0.435	0.019	0.002
CAN	0.542	0.079	0.047	1	0.218	0.338	-0.211	0.244	0.248	-0.012	0.404	0.138
DEN	0.088	0.043	-0.110	0.136	1	0.447	-0.161	0.217	0.054	-0.309	0.119	0.163
FRA	0.413	0.545	-0.520	0.149	0.361	1	-0.527	0.425	0.129	-0.205	0.162	0.039
FIN	-0.300	-0.490	0.321	-0.227	-0.102	-0.479	1	0.315	0.184	0.035	0.362	-0.498
ITA	0.209	0.147	-0.127	0.026	0.161	0.308	0.320	1	0.113	0.026	0.454	-0.395
NET	0.161	0.177	-0.298	0.118	0.019	0.011	0.204	0.020	1	-0.383	0.258	-0.182
NOR	-0.047	-0.029	0.337	0.065	-0.264	-0.120	0.028	0.068	-0.292	1	-0.156	0.034
SWE	0.160	-0.171	0.064	0.313	0.098	0.055	0.350	0.350	0.172	-0.094	1	-0.272
U.K	0.136	0.154	0.049	0.200	0.178	0.155	-0.431	-0.262	-0.194	0.032	-0.207	1

3-2. Estimation Results

We estimate the liquidity effect for 4 sample periods which are 1973-89, 1973-94, 1980-89, and 1980-94. Since SURE methods restricts the sample period to the common available period for all sample countries, our sample period for all countries can be extended only to December, 1989 since we are considering German data up to reunification. However, we estimate the equations for the period until 1994 with only the countries for which data are available by excluding Sweden (for which data can be extended only to 1990) and Germany. And we also exclude Canada and Finland for the

estimation for the periods which begin in 1973, since available data for these countries only goes back to the mid 1970s.

Figure 11 depicts the response of interest rates to the change of M1 for the period of 1980-1989 applying SURE to equation (2.1). In high CBI countries, liquidity effects are quite strong and persistent while in low CBI countries liquidity effects are much weaker than those of high CBI countries. Therefore, applying SURE for equation (2.1) does not change our previous results in any of the sample periods. Table 18 reports the regression results and Figure 12 depicts the estimation results clearly for the period of 1980-1989.

In all sample periods, the estimated results show that there is a strong inverse relationship, not only between CBI and the contemporary liquidity effect, but also between CBI and the minimum value of the liquidity effect. Also, it verifies the inverse relationship between CBI and the average liquidity effect. Finally, we count the number of months which show liquidity effects for a given time span and use this number as the value which represents duration of liquidity effects for the comparison with the results from using k values in dynamic correlation method that suggest a positive relationship between CBI and the duration of the liquidity effects. The estimation results confirm that CBI has strong positive effects on the duration of the liquidity effect. It seems that the liquidity effect would last about 5 months longer if we increased the CBI measure by 0.1 point.

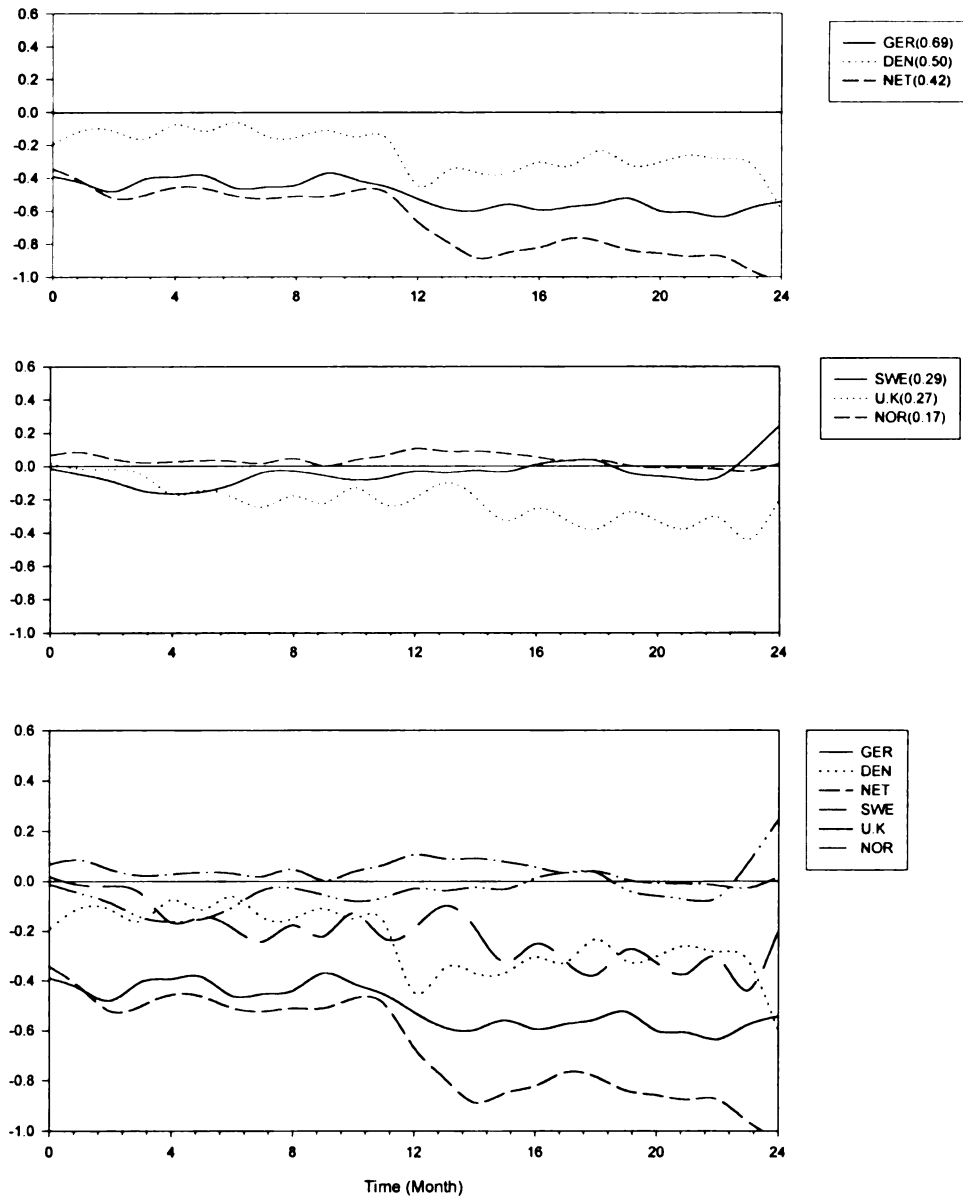


Figure 11. Response of R to $M1$ Change (1980~1989 : SURE Eq.(2.1))

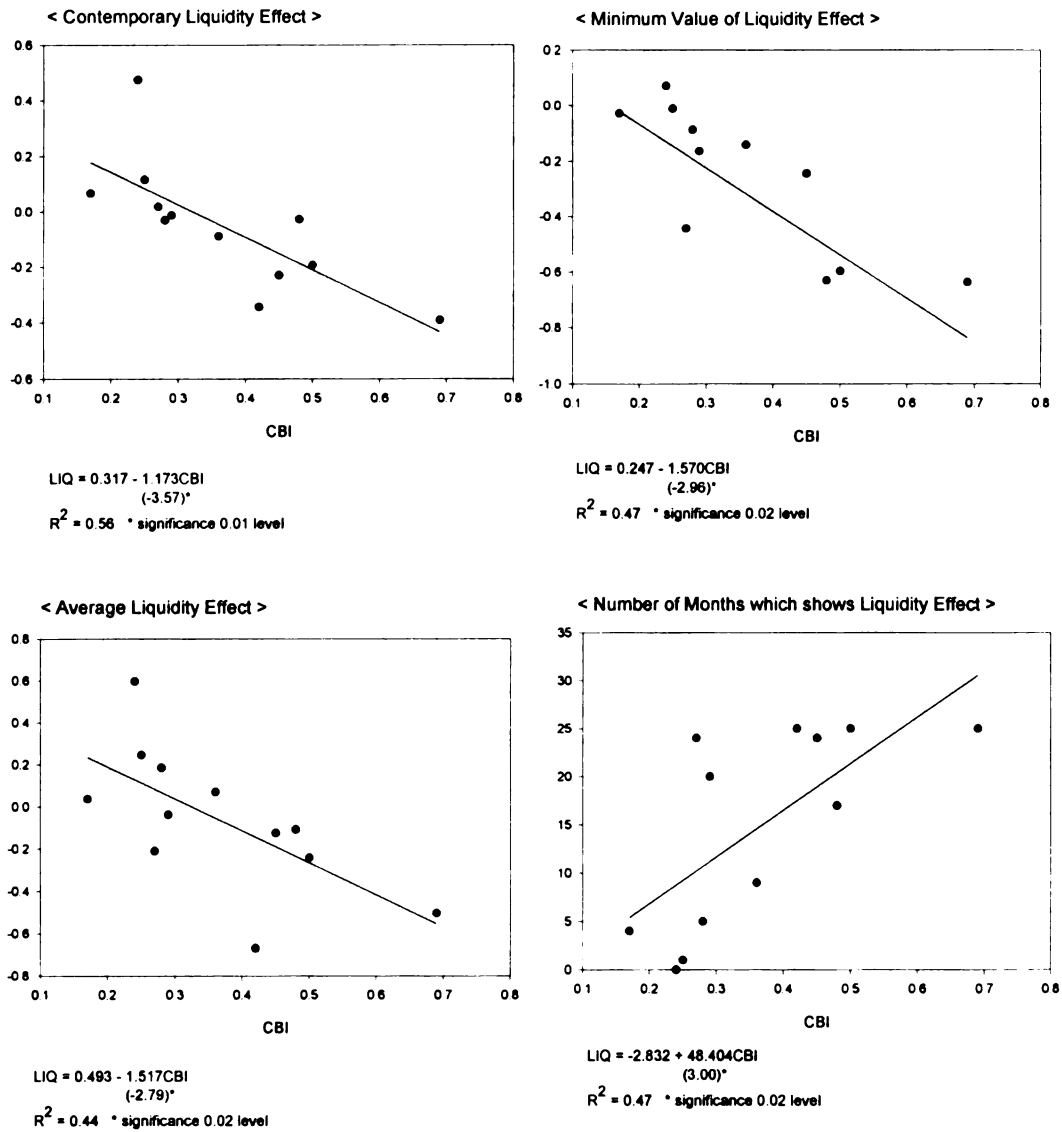


Figure 12. CBI and Liquidity Effects (1980~1989 : SURE Eq.(2.1))

Table 18. CBI and Liquidity Effects (SURE Eq.(2.1))

Dependent Variables	Explanatory Variables	'73-'89	'73-'94	'80-'89	'80-'94
Contemporary Liquidity Effect	Intercept	0.157	0.362	0.377	0.365
	CBI	-0.862**** (-4.58)	-1.636** (-2.61)	-1.173**** (-3.57)	-1.276**** (-4.95)
	R ²	0.72	0.53	0.56	0.75
Minimum Value of Liquidity Eff.	Intercept	0.107	0.266	0.247	0.317
	CBI	-1.041*** (-3.23)	-1.602*** (-2.91)	-1.570*** (-2.96)	-1.636* (-1.92)
	R ²	0.57	0.59	0.47	0.32
Average Liquidity Effect	Intercept	0.156	0.155	0.493	0.347
	CBI	-0.727* (-1.86)	-0.752* (-2.06)	-1.517*** (-2.79)	-1.250* (-1.95)
	R ²	0.30	0.41	0.44	0.32
Duration of Liquidity Effect	Intercept	1.449	-2.482	-2.832	-7.949
	CBI	37.196* (2.05)	54.595*** (2.88)	48.404*** (3.00)	64.470*** (2.88)
	R ²	0.34	0.58	0.47	0.51

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 5 percent level, *** at 3 percent level, and **** at 1 percent level.

With equation (2.3), SURE also confirms strong relationship between CBI and the liquidity effect. Figure 13 depicts the response of interest rate to the monetary shock by applying SURE to the equation (2.3). In Figure 13, we can find the strong and persistent liquidity effects in high CBI countries and much weaker liquidity effects in low CBI countries. To investigate the relationship between liquidity effect and central bank independence, we use the same kind of values as we did in the previous sections. Then, we regress the measure of central bank independence on these values. The regression results are reported in Table 19 and Figure 14 depicts the estimation results for some sample countries for the period of 1980-1989.

From the regression, we find that there is a significant inverse relationship between CBI and the contemporary liquidity effect for all 4 sample periods. For the periods of 1973-1989 and 1980-1989, CBI is also significantly inversely related to the minimum value of the liquidity effect, while for the periods of 1973-1994 and 1980-1994 there exist inverse relationships that are significant level at 11 percent and 13 percent respectively. CBI also has significant inverse relationship with the average liquidity effect and positive relationship with the duration of liquidity effect for the period of 1980-1989. For the period of 1980-1994 the estimation also shows a significant relationship between CBI and the duration of the liquidity effect. For the other sample periods, the estimated results have the signs we expected in the relationship between CBI and average liquidity effect and the relationship between CBI and duration of liquidity effect. However, these expected results are not significant.

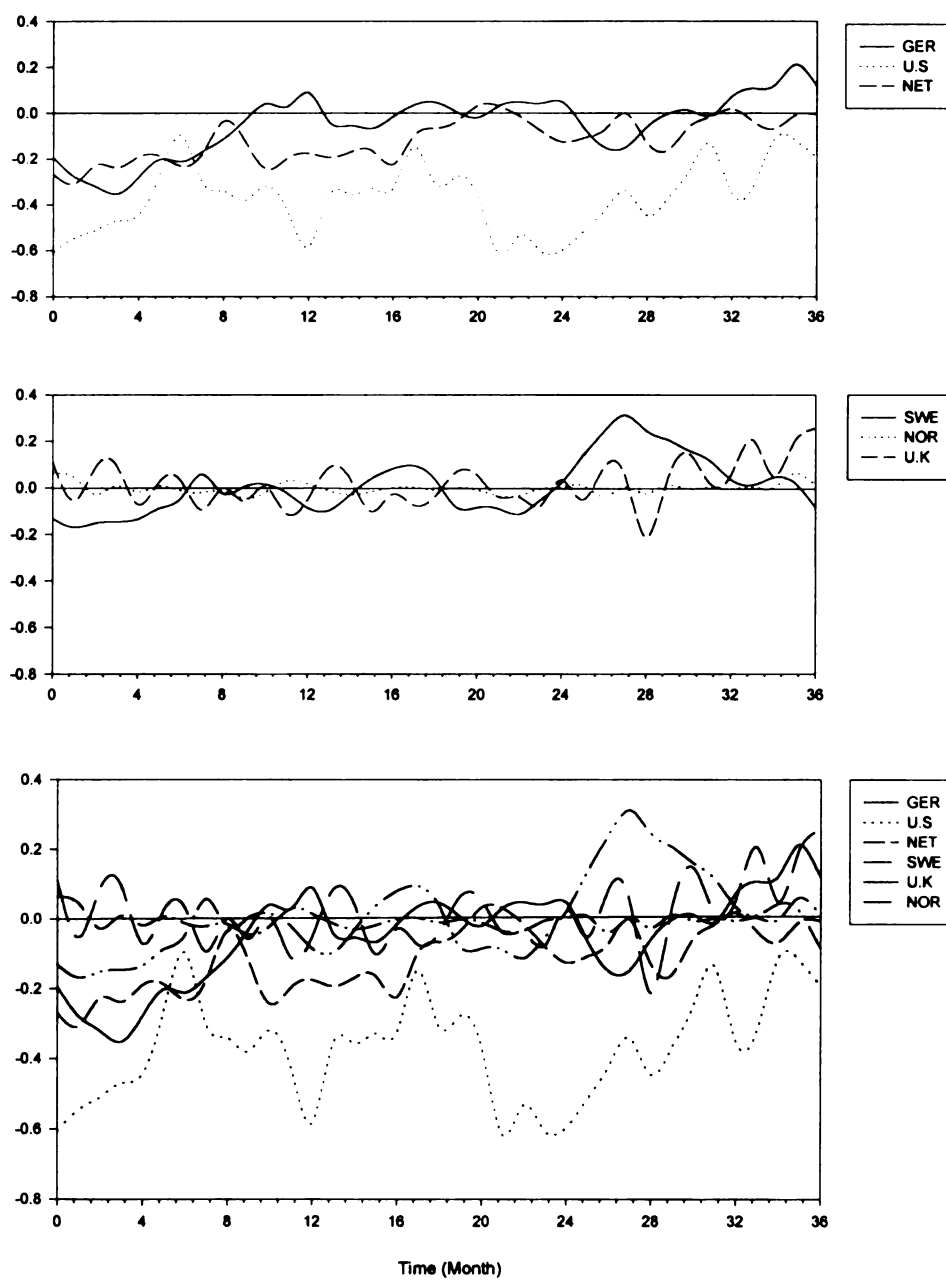


Figure 13. Response of R to M1 Change (1980~1989 : SURE Eq.(2.3))

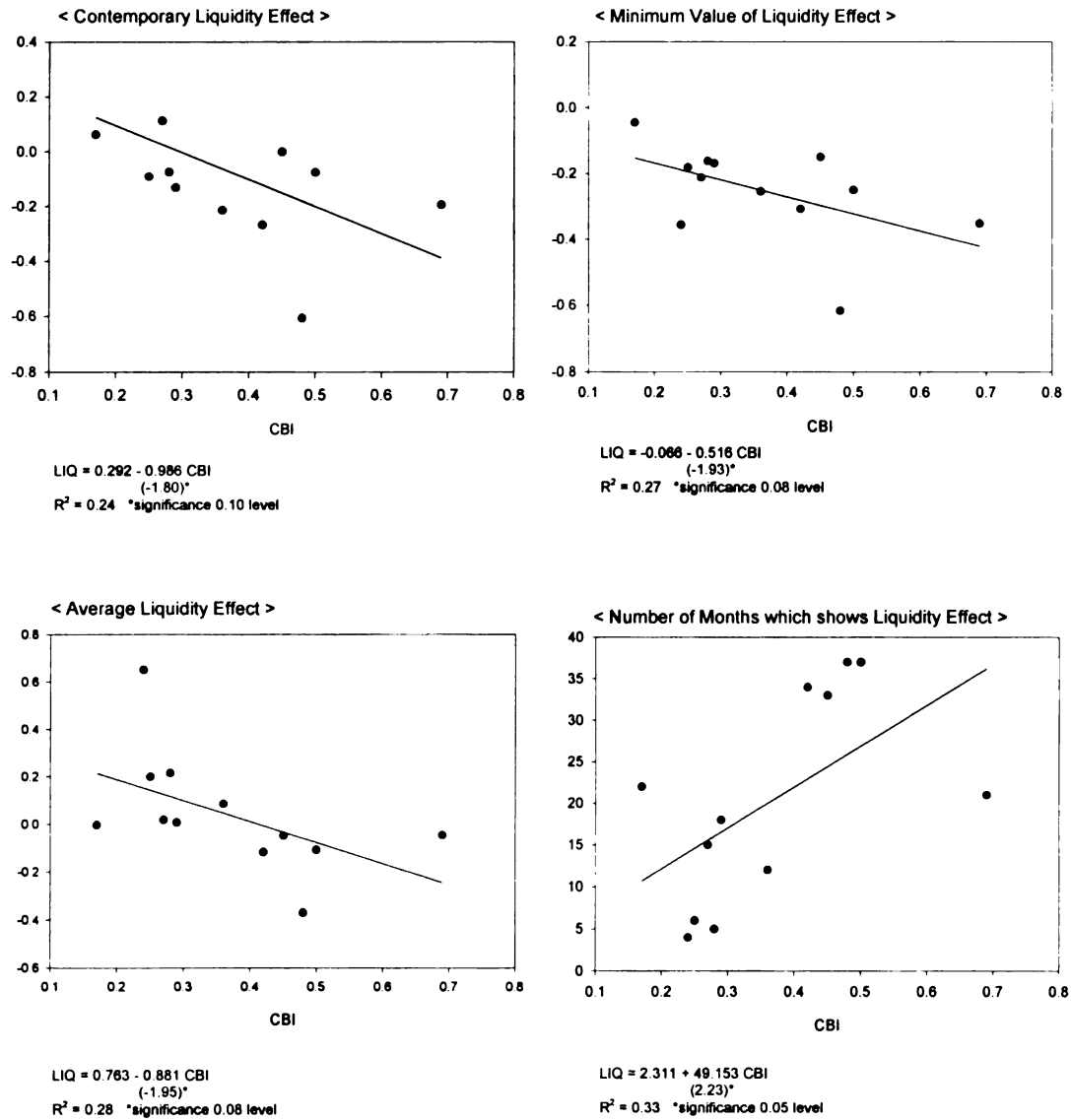


Figure 14. CBI and Liquidity Effects (1980~1989 : SURE Eq.(2.3))

Table 19. CBI and Liquidity Effects (SURE Eq.2.3)

Dependent Variables	Explanatory Variables	'73-'89	'73-'94	'80-'89	'80-'94
Contemporary Liquidity Effect	Intercept	0.143	0.388	0.292	0.472
	CBI	-0.899****	-1.839**	-0.986*	-1.707****
	R ²	(-3.84)	(-2.50)	(-1.80)	(-3.34)
		0.65	0.51	0.24	0.58
Minimum Value of Liquidity Eff.	Intercept	0.059	0.173	0.066	0.097
	CBI	-0.931***	-1.449*	-0.516*	-0.998
	R ²	(-3.27)	(-1.88)	(-1.93)	(-1.70)
		0.57	0.37	0.27	0.27
Average Liquidity Effect	Intercept	0.060	0.024	0.363	0.114
	CBI	-0.186	-0.157	-0.881*	-0.357
	R ²	(-0.84)	(-0.79)	(-1.95)	(-1.53)
		0.08	0.09	0.28	0.23
Duration of Liquidity Effect	Intercept	8.983	10.029	-2.311	8.198
	CBI	24.024	24.449	49.153**	41.820*
	R ²	(1.19)	(0.97)	(2.23)	(1.85)
		0.15	0.14	0.33	0.30

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 5 percent level, *** at 3 percent level, and **** at 1 percent level.

4. Summary

In this chapter, we estimated the liquidity effect by using three different traditional approaches and then we regress these liquidity effects on CBI measurement. The estimation results confirmed that the liquidity effects are inversely related with CBI. We found that the liquidity effects are much stronger and more persistent in high CBI countries than in low CBI countries. These results did not change when we applied SURE to the traditional approaches. These estimation results imply that CBI has significant effects not only on inflation level itself but also on monetary policy effects, so that credibility bonus effect exists.

However, as we pointed out at the beginning of this chapter, the traditional approaches do not correctly identify the liquidity effects. Therefore, in next chapter, we seek to identify the liquidity effect more clearly and correctly by using vector autoregression approaches and then we will investigate the relationship between these liquidity effects and CBI again.

CHAPTER IV

VECTOR AUTOREGRESSION APPROACHES

1. Nonstructural VAR Approaches

1-1. Vector Autoregression (VAR)

The traditional approaches suggest that there are inverse relationships between CBI and liquidity effects. The liquidity effects estimated by the traditional methods, however, can not be taken as evidence that unanticipated expansionary monetary policy disturbances drive interest rates down, because the traditional empirical approaches implicitly assume that no other variables induce interest rates and money aggregates to move together to generate the correlations estimated in these regressions. Therefore, the estimated relationship between CBI and liquidity effect may not be the real relationship because of problems in estimating liquidity effects by using the traditional approaches. At a minimum, providing such evidence requires identifying assumptions that are sufficiently strong to isolate a measure of the monetary policy disturbance. As it turns out from many studies, inference regarding the effects of monetary policy on interest rates hinges critically on two factors; the identifying assumptions used to obtain measures of unanticipated shocks to monetary policy, and the measure of money used in the analysis.

There are many different ways to solve the identification problem. These include event analysis (Romer and Romer, 1989, 1990), nonstructural VARs which are not

designed to be invariant to policy regime changes (Strongin, 1995), structural VARs which are designed to be invariant to policy regime changes (Leeper & Gordon, 1994), traditional general equilibrium models with detailed financial sectors (Gilles, Coleman, & Labadie, 1993), and real business cycle models with an appended monetary sector (Christiano, 1991)

With regard to the measure of money, some studies use a monetary aggregate as the measure of exogenous policy disturbances (M-rule). Among the monetary aggregates used we find non-borrowed reserves (NBR), M0, and M1. When monetary aggregates are used to measure exogenous policy disturbances, a liquidity puzzle problem arises consistently which is that innovations in the monetary aggregates seem to be associated with rising, rather than falling interest rates. This puzzle has been surveyed by Reichenstein (1987) and was recently redocumented by Leeper and Gordon (1992). Leeper and Gordon (1992) show that the relationship between innovations in the monetary aggregate and interest rates is highly uncertain, varies across time, and usually has the opposite sign to the theoretical prediction. Christiano and Eichenbaum (1992) also found no liquidity effect with M0 or M1, but with NBR they found a persistent liquidity effect. However, we need to note that all these studies have been done only on U.S data.

The liquidity puzzle with a money based measure for monetary policy led Sims (1992) and Bernanke and Blinder (1992), among others, to identify monetary policy directly with innovations in interest rates (R-rule). This identification scheme is relatively successful in producing results consistent with a priori expectations about the effects of monetary policy. However, according to Strongin (1995), this approach also has a problem. He

argues that, without any demonstrated empirical linkage between central bank actions and interest rate movements, it is unclear how innovation in interest rates can reasonably be attributed to monetary policy.

In this paper, we will apply R-rule to each country since with M-rule we could find a liquidity effect only in a few European countries among all eleven sample countries.³⁰ This is consistent with other studies which found no liquidity effects with M-rule (M1) in U.S. Therefore, in the next section, we estimate the relationship between CBI and the liquidity effect only with R-rule. We use M1 for the monetary aggregate because it is available for all the countries we examine here.

To clarify the nature of the identifying assumptions that have been used in this paper, suppose that the economy evolves according to $Ay_t = B(L)y_t + \varepsilon_t$. Here, y_t denotes the time t values of the variables summarizing the state of the economic system. y_t includes the time t values of the observable endogenous nonpolicy variables (y_{1t}) as well as the time t values of the policy instruments (y_{2t}). The fundamental sources of uncertainty in this economy are summarized by the i.i.d. random variable ε_t , which has the property that $E\varepsilon_t\varepsilon_t' = I$ where I denotes the identity matrix. The vector ε_t is partitioned as $\varepsilon_t = [\varepsilon_{1t} \varepsilon_{2t}]'$. With this notation, ε_{2t} represents the fundamental disturbances to policy variable (y_{2t}). The constant matrix A summarizes the manner in which the contemporaneous values of y_t are related to each other, while $B(L)$ is a matrix polynomial in positive powers of the lag operator L .

³⁰ In VAR approaches, we exclude Australia from the previous 12 countries because of non-availability in data

Now suppose we are interested in examining the historical effects of policy disturbances, that is, we want to characterize the dynamic effects of past variations in y_{2t} , arising from different values of ε_{2t} , on y_{1t} . Given values for A and $B(L)$, these responses can be calculated from the moving average representation of the system

$$y_t = C(L) \varepsilon_t = \sum_0^{\infty} C_s \varepsilon_{t-s} \text{ where } C(L) = A^{-1} [I - B(L)]^{-1}.$$

Under our assumptions, the (k, j) element of C_s gives the response of the k^{th} element of y_{t+s} to a unit disturbance in the j^{th} element of ε_t .

Suppose we are modeling a four variable VAR system. For example, if we define that the first element of y_t as the price level, the second element as the income level, the third element as the interest rate level and the fourth element as the level of the money aggregate. A p th-order vector autoregression, denoted VAR(p), can be written as

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \dots + \Phi_p y_{t-p} + \varepsilon_t. \quad (4.1)$$

$$\text{where } y_t = [P_t \ Y_t \ R_t \ M_t]'$$

$$\varepsilon_t = [\varepsilon_{1t} \ \varepsilon_{2t} \ \varepsilon_{3t} \ \varepsilon_{4t}]'$$

Here c denotes an (4×1) vector of constant and Φ an (4×4) matrix of autoregressive coefficients for $j = 1, 2, \dots, p$. The (4×1) vector ε is a vector generalization of white noise:

$$E(\varepsilon_t) = 0 \quad (4.2)$$

$$E(\varepsilon_t \varepsilon_{\tau}') = \Omega \text{ for } t = \tau$$

$$0 \text{ otherwise,}$$

with Ω an $(n \times n)$ symmetric positive definite matrix.

Using lag operator, (4.1) can be written in the form

$$[I - \Phi_1 L - \Phi_2 L^2 - \dots - \Phi_p L^p] y_t = c + \varepsilon_t \quad (4.3)$$

$$\text{or } \Phi(L)y_t = c + \varepsilon_t,$$

where $\Phi(L)$ indicates an (4×4) polynomial matrix in the lag operator L .

Now, VAR(p) can be written in vector MA(∞) form as

$$y_t = k + \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + \dots \quad (4.4)$$

$$\text{or } y_t = k + \Psi(L) \varepsilon_t$$

$$\text{where } \Psi(L) = [\Phi(L)]^{-1} \text{ and } k = [\Phi(1)]^{-1}c$$

Thus, the matrix Ψ has the interpretation

$$\partial y_{t+s} / \partial \varepsilon_t = \Psi_s ; \quad (4.5)$$

that is, the row i , column j element of Ψ_s identifies the consequences of a one-unit increase in the j^{th} variable's innovation as date t (ε_{jt}) for the value of i^{th} variable at time $t+s$ ($y_{i,t+s}$), holding all other innovations at all dates constant.

If we were told that the first element of ε_t (ε_{1t}) changed by δ_P at the same time that the second element changed by δ_Y , the third element changed by δ_R , and the fourth element by δ_M , then the combined effect of these changes on the value of vector y_{t+s} would be given by

$$\Delta y_{t+s} = (\partial y_{t+s} / \partial \varepsilon_{1t}) \delta_P + (\partial y_{t+s} / \partial \varepsilon_{2t}) \delta_Y + (\partial y_{t+s} / \partial \varepsilon_{3t}) \delta_R + (\partial y_{t+s} / \partial \varepsilon_{4t}) \delta_M = \Psi_s \delta, \quad (4.6)$$

$$\text{where } \delta = [\delta_P, \delta_Y, \delta_R, \delta_M]'$$

Now set $y_{t-1} = y_{t-2} = \dots = y_{t-p} = 0$, $\varepsilon_{jt} = 1$, and all other elements of ε_t to zero, and simulate the system (4.1) for dates $t, t+1, t+2, \dots$, with c and $\varepsilon_{t+1}, \varepsilon_{t+2}, \dots$ all zero.

The value of the vector y_{t+s} at date $t + s$ of this simulation corresponds to the j^{th} column of ψ_s . By doing a separate simulation for impulses to each of the innovations ($j = 1, 2, 3, 4$), all of the columns of ψ_s can be calculated.

A plot of the row i , column j element of ψ_s ,

$$\partial y_{i,t+s} / \partial \varepsilon_{jt}, \quad (4.7)$$

as a function of s is called the impulse response function. It describes the response of $y_{i,t+s}$ to a one-time impulse in y_{jt} with all other variables dated t or earlier held constant.

Here, we derive the impulse response function of the variables to the shock of each variable to get the liquidity effects in each country. For example, Figure 15 and Figure 16 depict these impulse response functions for a 4 variable VAR system of U.S in (R,M,Y,P) order and for a 5 variable VAR system in (Y,P,CP,R,M) order respectively for the period of 1980-1994.³¹ The dotted lines represent the estimated confidence bands constructed from Monte Carlo integration method. In the Figure 15, for example, the first graph in the second column represents the liquidity effects since the impulse response of M_t to the shock of R_t depicts the liquidity effect in the R-rule. By applying VAR to each country, we get the impulse responses which indicate the liquidity effects from all sample countries. Figure 17 depicts the impulse response functions of all countries in the sample which represent the liquidity effects in a 4 variable VAR (R,M,Y,P) order.

³¹ In 5 variable VAR system, we include commodity price index(CP).

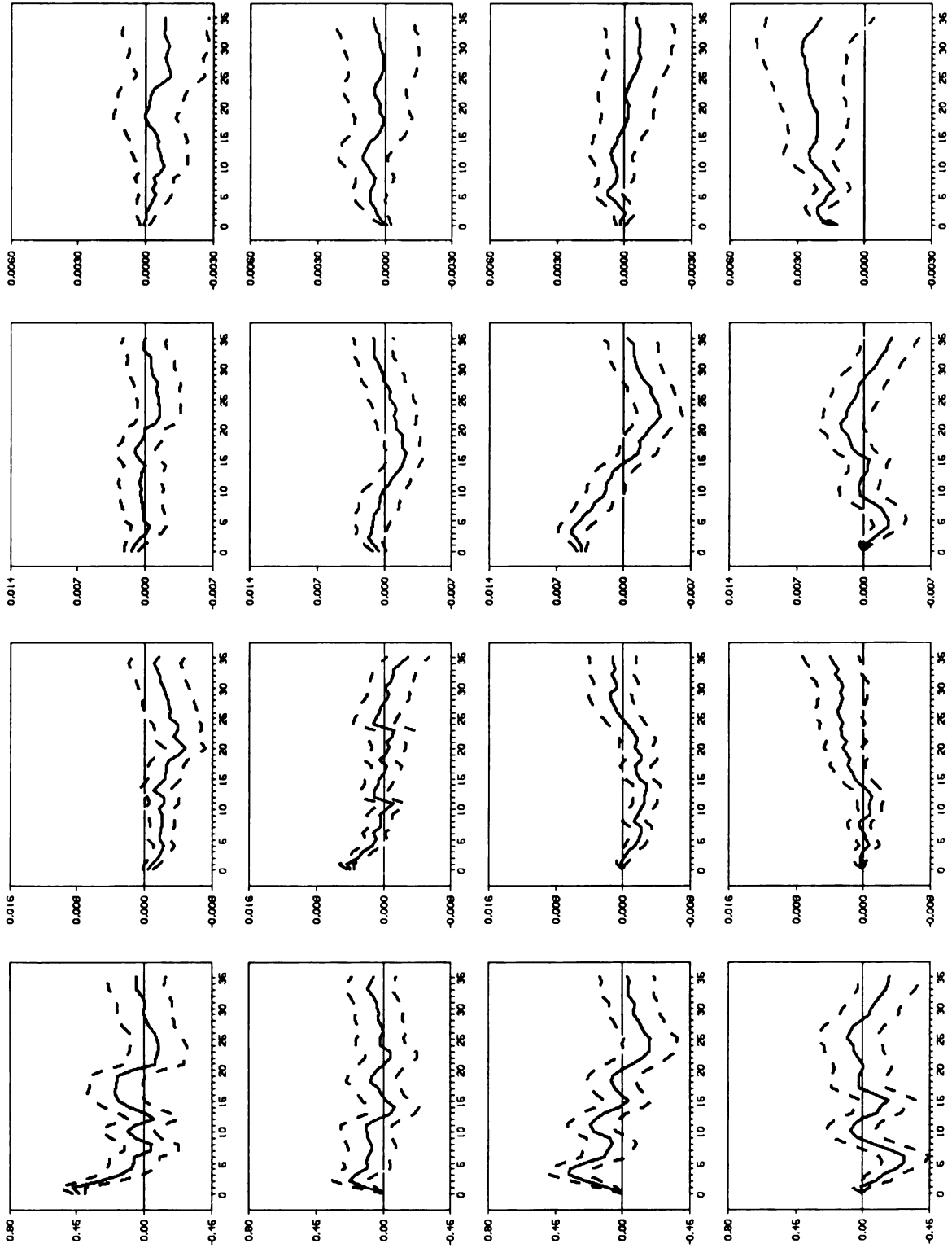


Figure 15. Impulse Responses in (R,M,Y,P) : U.S.

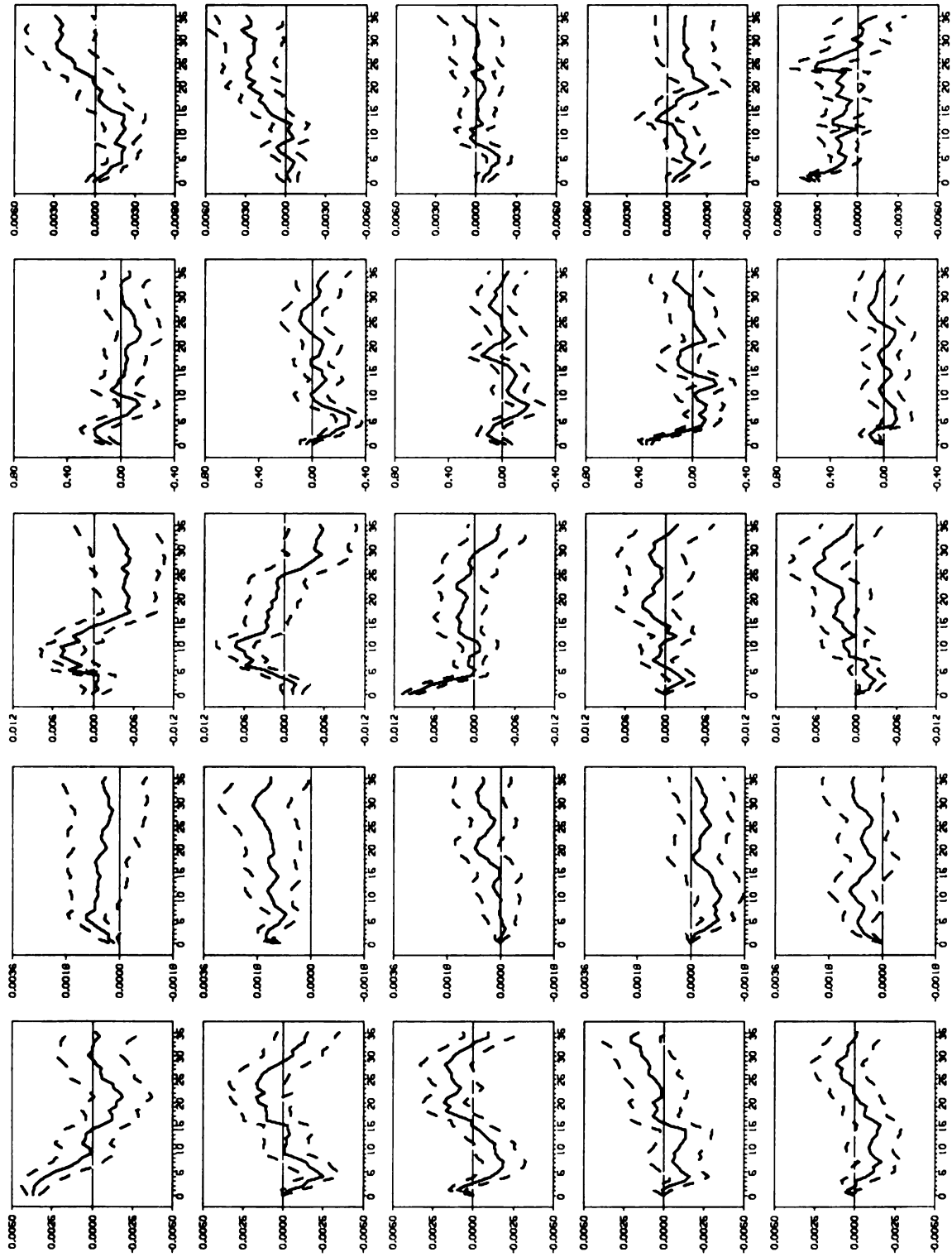


Figure 16. Impulse Responses in (Y,P,CP,R,M) : U.S.

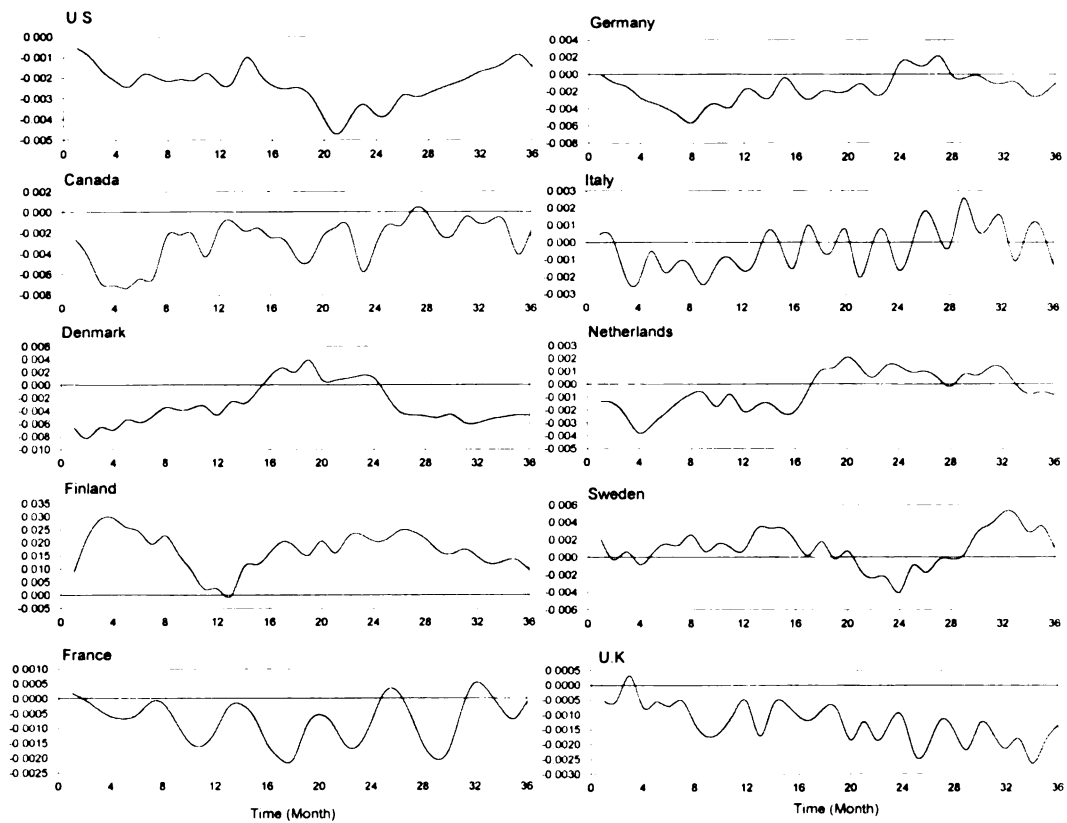


Figure 17. Liquidity Effects in (R,M,Y,P)

1-2. Four Variables VAR Estimation.

We will measure the shock to monetary policy as an orthogonalized component of the innovation to the short interest rates with the ordering as (R,M,Y,P) suggested by Christiano and Eichenbaum (1992), which corresponds to the identification scheme imposed by Bernanke and Blinder (1992) as well as Sims (1986). We examine the relationship with the alternative ordering (P,Y,R,M) in which the unanticipated change in monetary policy is measured at the point of the innovation in interest rate that is orthogonal to the innovations in both P_t and Y_t , but not M_t . We also analyze the relationship with the alternative ordering (P,R,M,Y), which the unanticipated change in monetary policy is measured at the point of the innovation in interest rate that is orthogonal to the innovation in P_t , but not M_t and Y_t . This means that in setting R_t the monetary authority looks at P_t but not Y_t and M_t .

With these 3 different orderings, we estimate impulse responses of each variable to the monetary shock. The impulse response of M_t to the shock of R_t depicts the liquidity effect in the R-rule. In the Figure 15, for example, the first graph in the second column represents the liquidity effects. From this impulse response function, we get the contemporary liquidity effect and the minimum value of liquidity effect given the time span. We count the number of months which show liquidity effect given the time span and consider this number as the duration of the liquidity effect. We also sum the response of M1 after the R-shock and use this aggregate response as the average liquidity effect, as we did in the previous sections.

The estimated results for the relationship between CBI and liquidity effect seem to be little affected by choice of orderings for constructing liquidity effect.³² The Figures 18, 19 and 20 shows these relationships. CBI is very significantly related to the minimum value of liquidity effect in all 3 orderings. The duration of the liquidity effect is positively related with CBI at the 8% to 10% significance level for all 3 orderings. The results show that 0.1 point increase in CBI will make the liquidity effect last about 4 months longer. We can get the same relationship as we expected in both the relationship between CBI and contemporary liquidity effect and the relationship between CBI and average liquidity effect. But these are significant only at the 11% to 18% level.

³² Here, we report the estimation results only for the period of 1980-1994. Actually, there was little difference in the estimation results between for the period of 1980-1994 and 1970-1994. For the period of 1970-1979, we found weaker relationships between CBI and liquidity effects than those for other two sample periods.

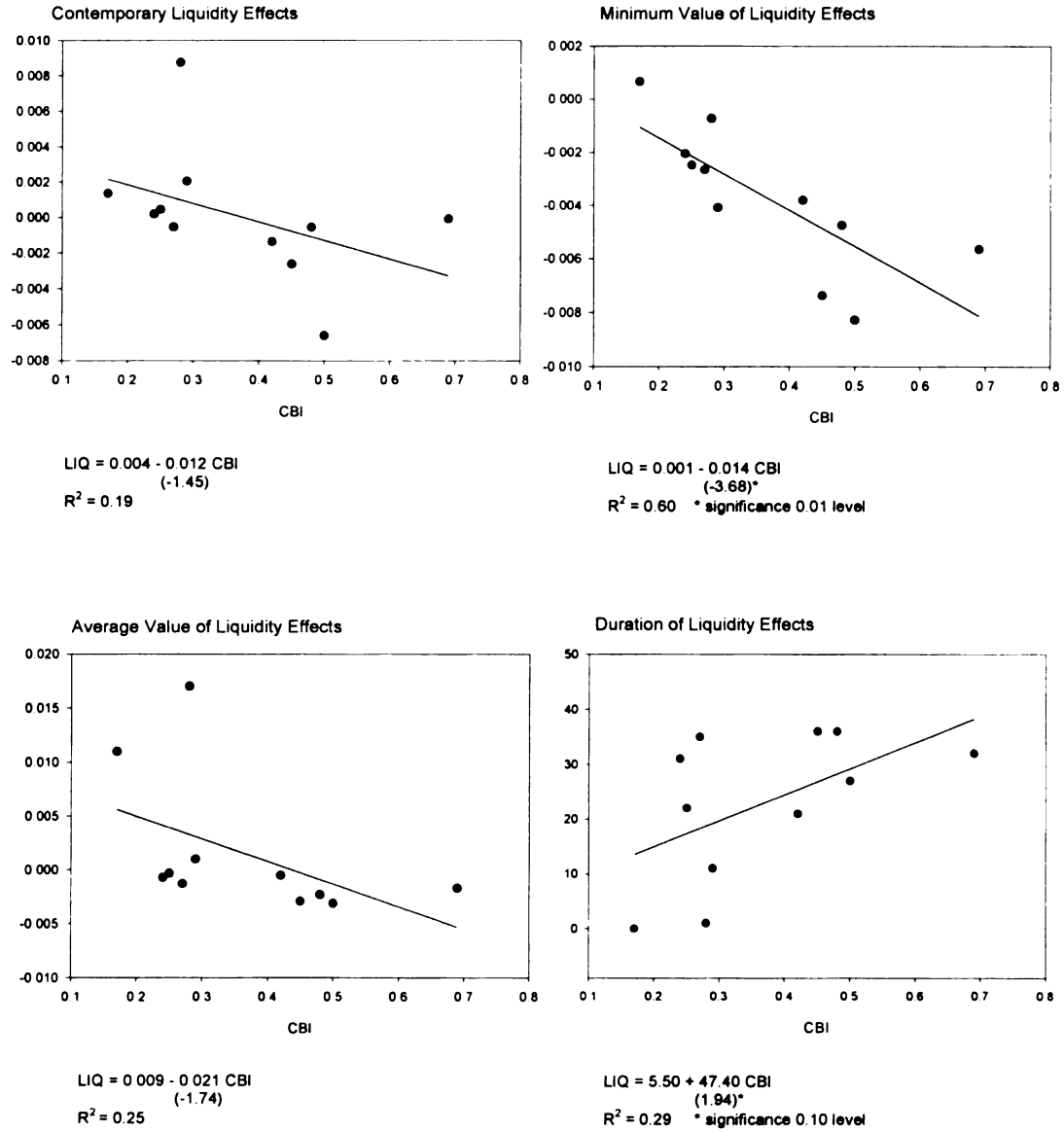


Figure 18. CBI and Liquidity Effects : (R,M,Y,P)

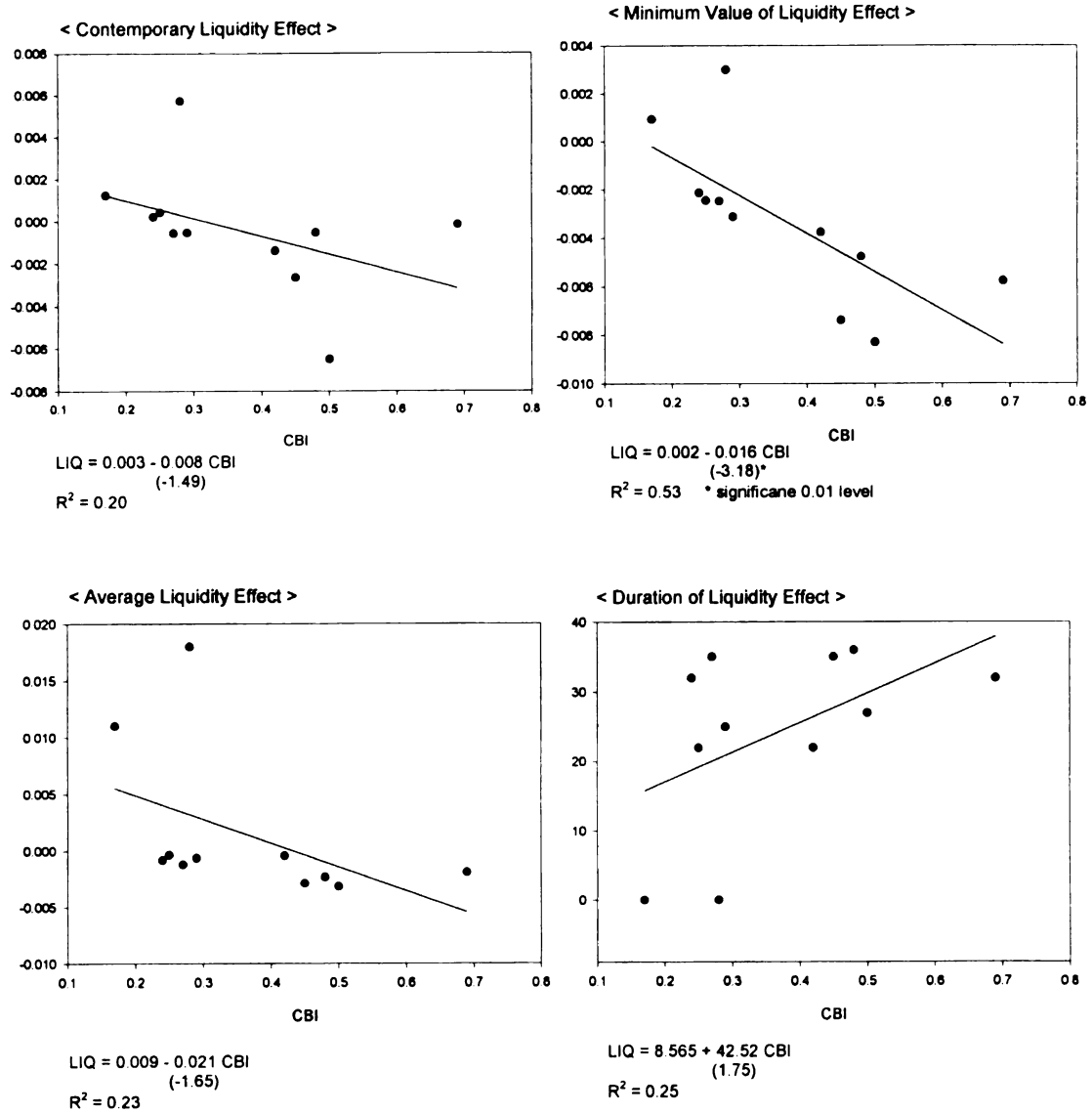


Figure 19. CBI and Liquidity Effects : (P,R,M,Y)

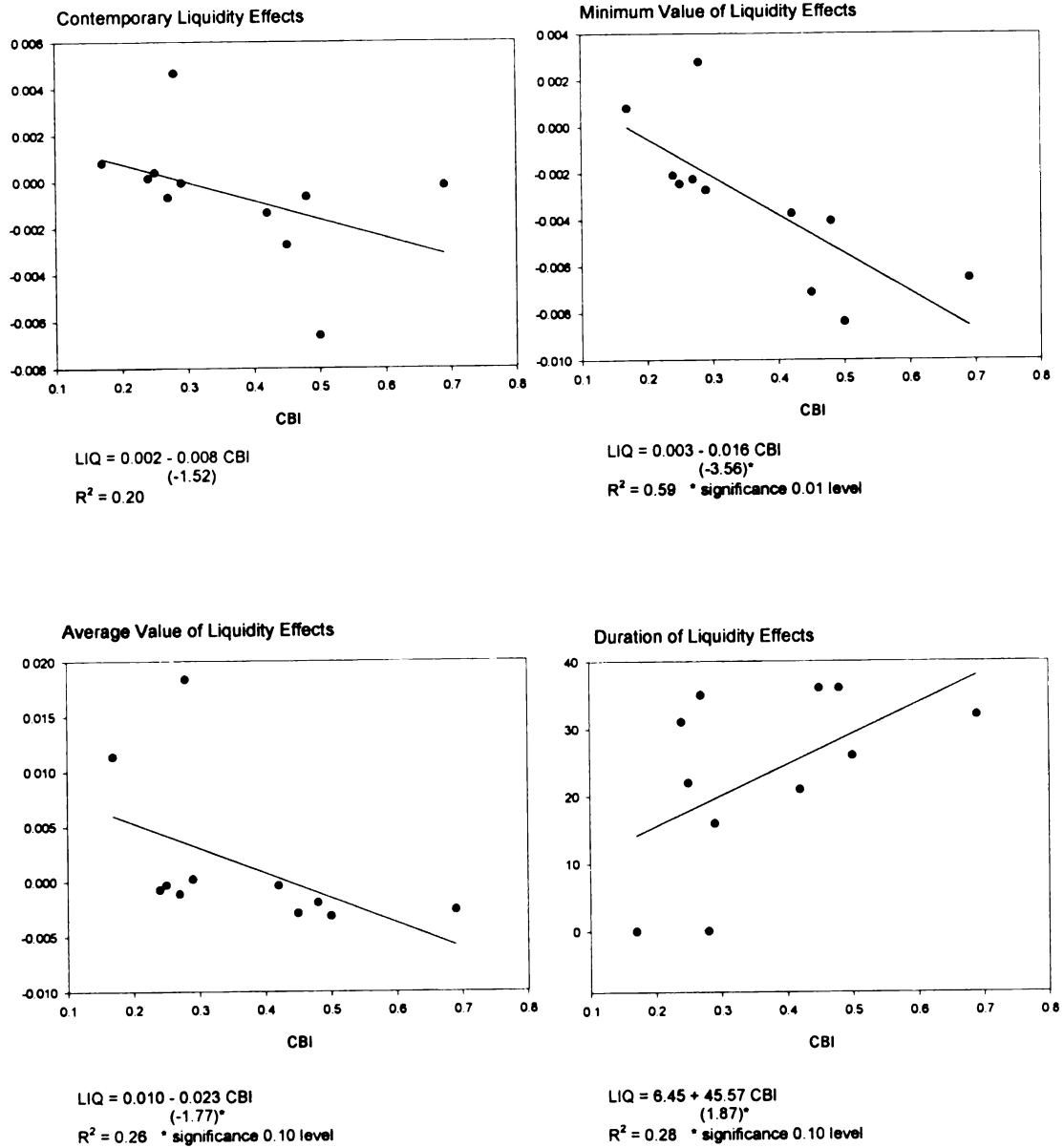


Figure 20. CBI and Liquidity Effects : (P,Y,R,M)

Table 20. CBI and Liquidity Effects (4 variable VAR)

Dependent Variables	Explanatory Variables	(R,M,Y,P)	(P,R,M,Y)	(P,Y,R,M)
Contemporary Liquidity Effect	Intercept	0.004	0.003	0.002
	CBI	-0.012 (-1.45)	-0.008 (-1.49)	-0.008 (-1.52)
	R ²	0.19	0.20	0.20
Minimum Value of Liquidity Eff.	Intercept	0.001	0.002	0.003
	CBI	-0.014** (-3.68)	-0.016** (-3.18)	-0.016** (-3.56)
	R ²	0.60	0.53	0.59
Average Liquidity Effect	Intercept	0.009	0.009	0.010
	CBI	-0.021 (-1.74)	-0.021 (-1.65)	-0.023* (-1.77)
	R ²	0.25	0.23	0.26
Duration of Liquidity Effect	Intercept	5.501	8.565	6.45
	CBI	47.401* (1.94)	42.520 (1.75)	45.57* (1.87)
	R ²	0.29	0.25	0.28

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 1 percent level.

1-3. Five Variables VAR Estimation.

In this section, we include a measure of commodity prices (CP) to avoid the “price puzzle” which is the result that positive orthogonalized innovations to interest rates are associated with a prolonged rise in the price level.³³ Sims (1992) conjectured that this response reflects the fact that the Fed has an indicator of inflation in its reaction function that is missing from the VAR underlying the policy shocks measure. After including commodity prices in VAR system many authors find no price puzzle.³⁴ We will examine this possibility with a multicountry sample. Here, we add a commodity price index CP(IFS..00176AXD) to a four variable VAR system.

Following Sims (1992), we will use R-rule in which the identification schemes used to interpret the data will rely mainly on postulating that innovations in short interest rates represent monetary policy disturbances and estimate impulse responses for the five-variable VAR estimates for 11 countries. The responses are for orthogonalized innovations with the ordering as (R,CP,M,P,Y). Next, we will assume that monetary authority sets a monetary policy after watching the macroeconomic aggregates, and that monetary policy can not affect these aggregates in the contemporaneous period. This assumption corresponds to the ordering as (Y,P,CP,R,M). Finally, we will assume that the monetary authority can not consider the level of Y_t when they set the policy. Since there is a time lag in obtaining Y_t data, it is impossible to consider Y_t of the period during which they set the policy. But they can get contemporaneous price variables before

³³ Actually, we found no price puzzle with U.S data for the sample periods that extend to 1994. The price level decreases after a monetary contraction. This response of price level is shown in the fourth column of the first graph in the Figure 13.

setting the policy. This assumption corresponds to the ordering as (P,CP,R,M,Y). From the impulse responses of the 5 variable VAR system, we get the liquidity effects with which to estimate the relationship with CBI. For example, in the Figure 16, the fourth graph in the last column depicts the liquidity effects in the economy and we find no price puzzle which is represented by the fourth graph in the second column.

The estimated results for the relationship between CBI and liquidity effect meet our expectations which are represented by the Figures 21, 22 and 23.³⁵ Table 21 summarized estimation results. The contemporaneous liquidity effect is significantly inversely related with CBI in the (Y,P,CP,R,M) and the (P,CP,R,M,Y) orderings. The minimum value of the liquidity effect is also inversely related with CBI at 10% significance level in (Y,P,CP,R,M) ordering, but the relationship is not significant in the (R,M,P,Y,CP) and the (P,CP,R,M,Y) orderings, even though the signs of coefficients are negative as we expected. We also find the inverse relationship with CBI and the average liquidity effect in all orderings. Finally, duration of liquidity effect shows the strongest relationship with CBI in these 5 variable VAR systems. CBI has significant positive effects on the duration of the liquidity effects in all 3 orderings. We can expect 5 more months of the liquidity effect after a monetary shock if we improve CBI measurement by 0.1 point.

³⁴ See Eichenbaum (1992), Sims (1992), Christiano et al. (1996))

³⁵ We report the estimation results only for the period of 1980-1994. For the period of 1970-1994, the estimation results have little difference from those we report here. But the relationships are weaker for the period of 1970-1979 as they were in the 4 VAR system.

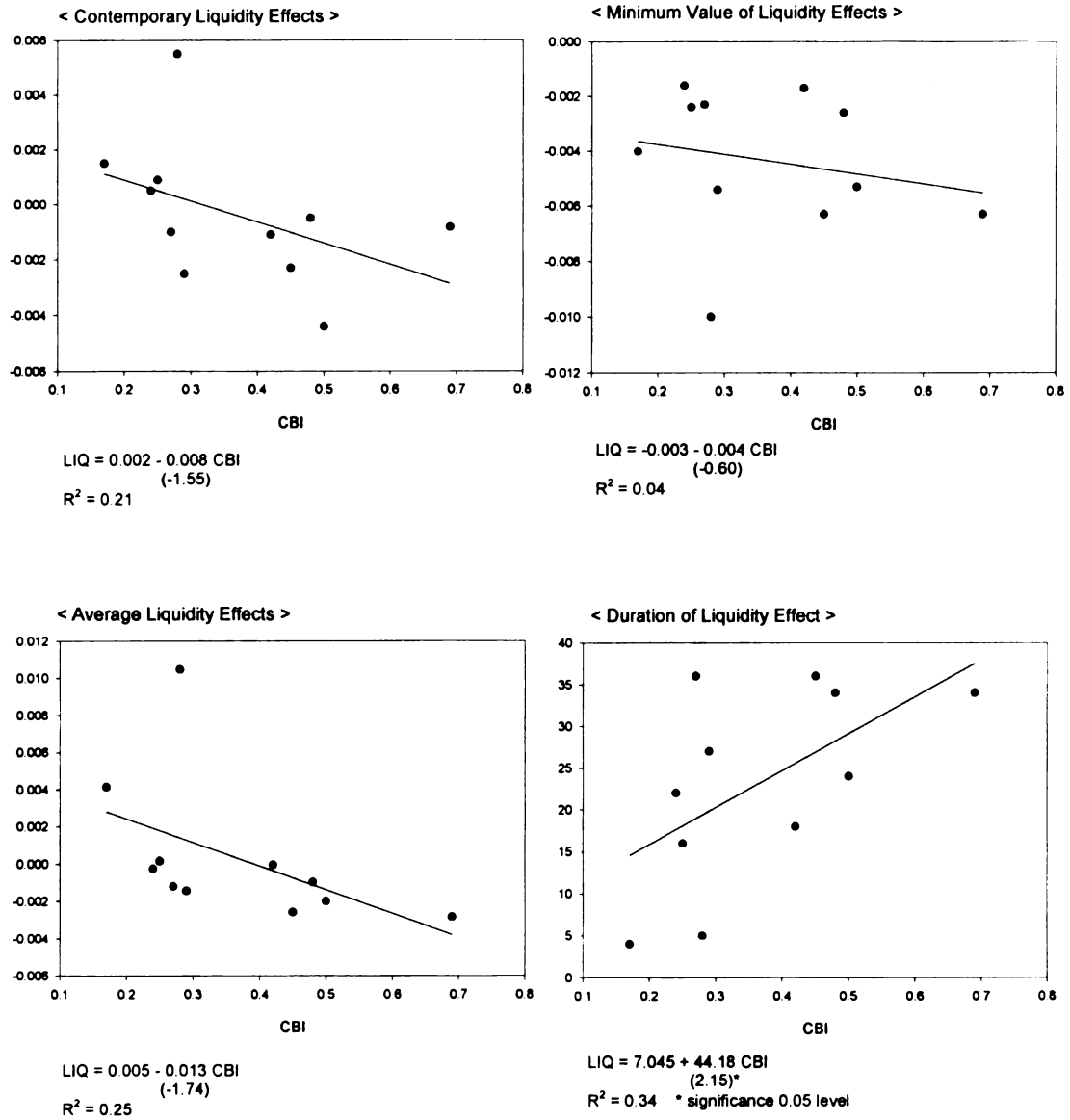


Figure 21. CBI and Liquidity Effects : (R,M,P,Y,CP)

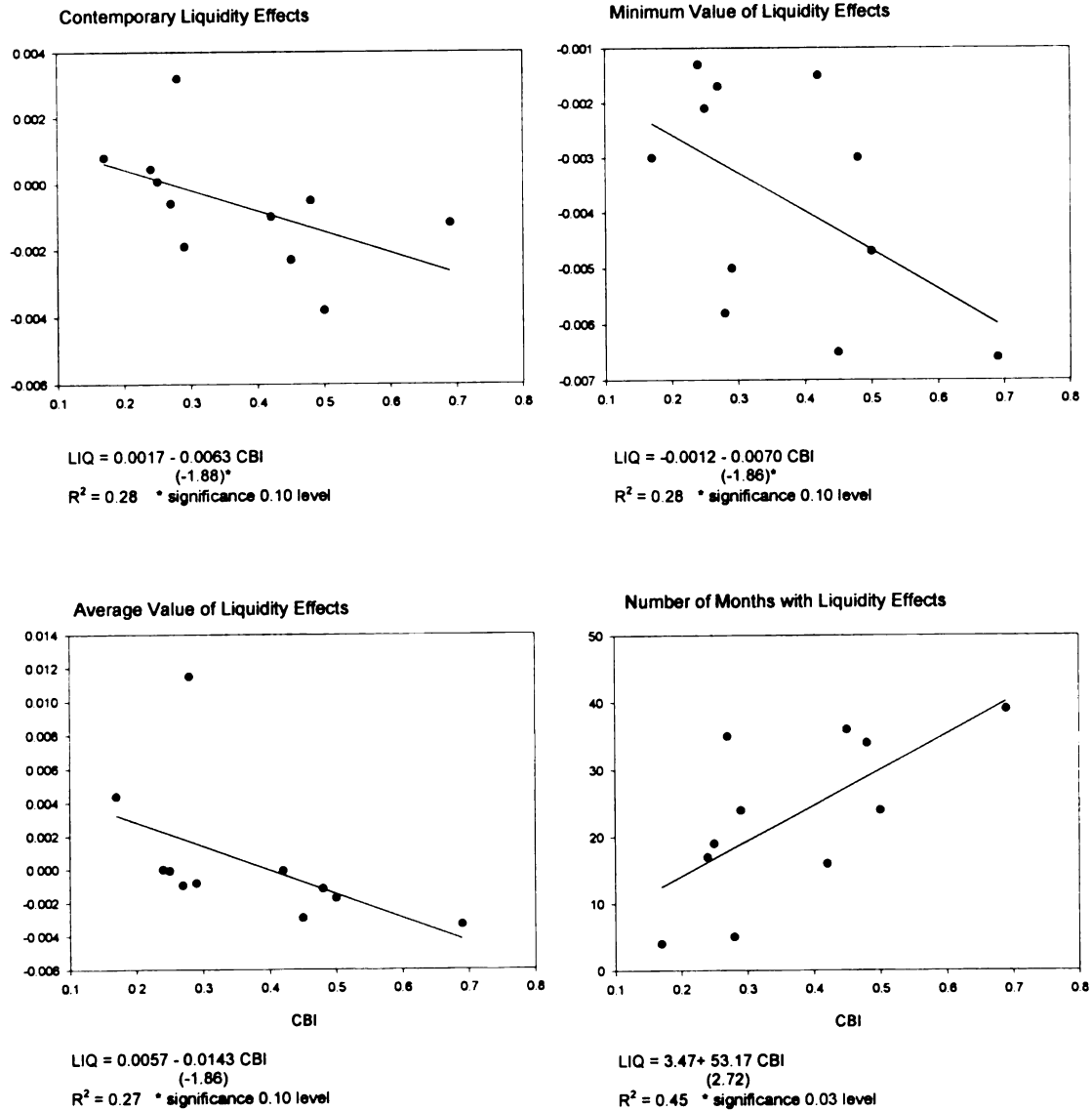


Figure 22. CBI and Liquidity Effects : (Y,P,CP,R,M)

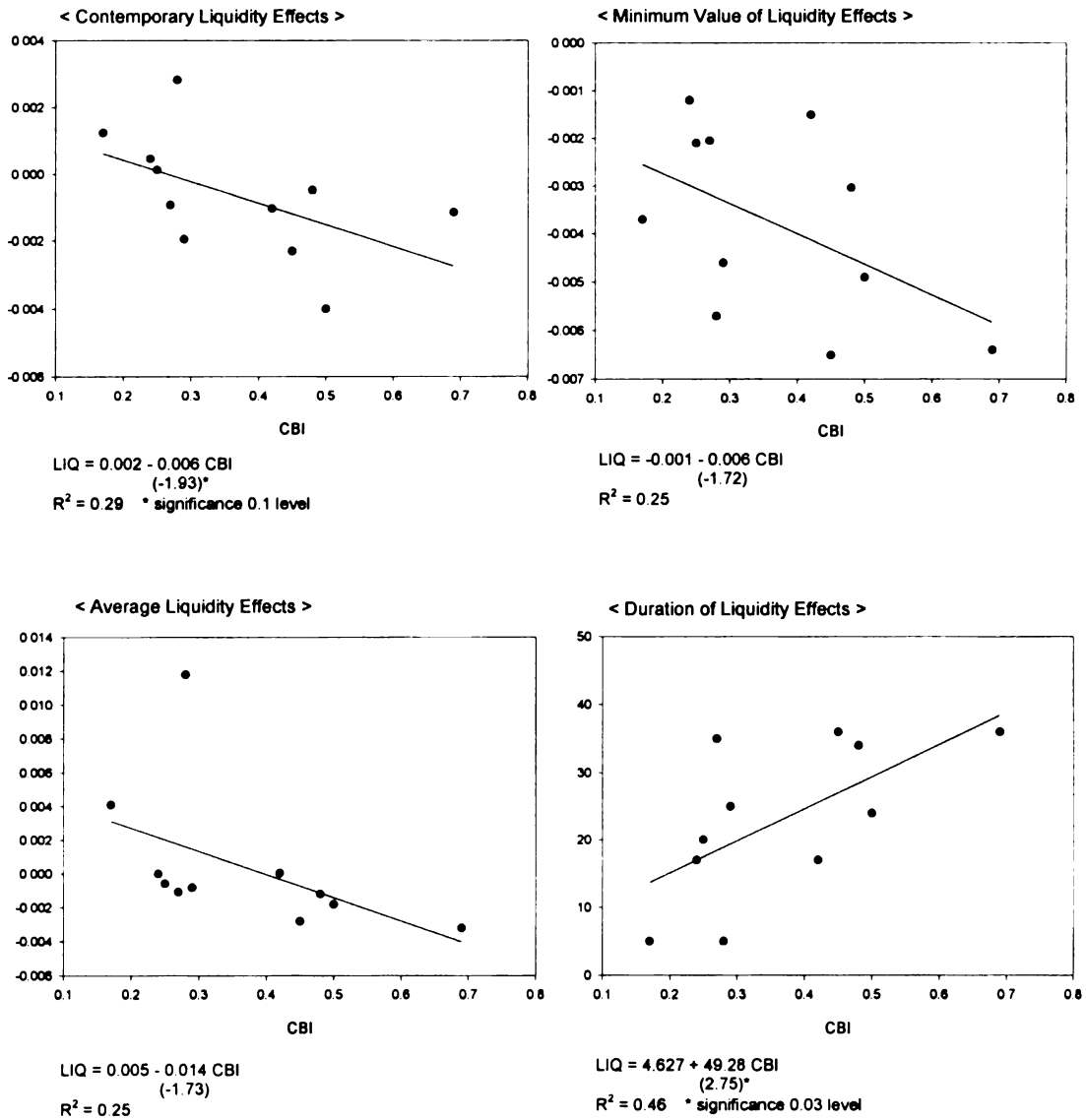


Figure 23. CBI and Liquidity Effects : (P,CP,R,M,Y)

Table 21. CBI and Liquidity Effects (5 variable VAR)

Dependent Variables	Explanatory Variables	(R,M,P,Y,CP)	(Y,P,CP,R,M)	(P,CP,R,M,Y)
Contemporary Liquidity Effect	Intercept	0.002	0.002	0.002
	CBI	-0.008 (-1.55)	-0.006* (-1.88)	-0.006* (-1.93)
	R ²	0.21	0.28	0.29
Minimum Value of Liquidity Eff.	Intercept	-0.003	-0.001	-0.001
	CBI	-0.004 (-0.60)	-0.007* (-1.86)	-0.006 (-1.72)
	R ²	0.04	0.28	0.25
Average Liquidity Effect	Intercept	0.005	0.006	0.005
	CBI	-0.013 (-1.74)	-0.014* (-1.86)	-0.014 (-1.73)
	R ²	0.25	0.27	0.25
Duration of Liquidity Effect	Intercept	7.045	3.471	4.627
	CBI	44.184** (2.15)	53.170*** (2.72)	49.284*** (2.75)
	R ²	0.34	0.45	0.46

Note : The t-statistics are reported in parentheses. * indicates significance at the 10 percent level, ** at 5 percent level, *** at 3 percent level.

2. Structural VAR Approaches.

2-1. Structural VAR.

In a VAR system we estimated liquidity effect by the (k,j) element of C_s which gives the response of k^{th} element of y_{t+s} to a unit disturbances in the j^{th} element of ε_t , that is, monetary innovation from the system $y_t = C(L)\varepsilon_t = \sum C_s \varepsilon_{t-s}$, where $C(L) = A^{-1}[I - B(L)]^{-1}$. The problem with this procedure is that we can not directly observe or estimate ε_{2t} which represents the vector of policy disturbances. The VAR of y_t is given by $y_t = G(L) y_{t-1} + \mu_t$ where $G(L) = A^{-1}B(L)$, $\mu_t = A^{-1}\varepsilon_t$ and $E\mu_t\mu_t' = A^{-1}(A^{-1})' = D$.

Without additional restrictions on the system, we can estimate D and $G(L)$, but A and $B(L)$ are not identified. We can calculate the moving average representation as $y_t = Z(L)\mu_t$ where $Z(L) = [I - G(L)]^{-1}$. But without very special assumptions regarding matrix A , μ_t 's are not equal to ε_t 's. This means that dynamic response of nonpolicy variables in y_t to shocks in ε_t will not coincide with the dynamic response of those variables to shocks in μ_t .

In order to resolve this problem, sufficiently strong restrictions must be imposed to identify the matrix A . While various procedures have been adopted by empirical studies, the type of restrictions most relevant for the existing liquidity effect is restrictions on the contemporaneous nature of feedback between the elements of y_t , that is, restrictions on the matrix A . Most researchers in the area have proceeded by adopting a particular Wold

causal interpretation of the data. The general idea is to assume that the matrix A is triangular when the variables y_t are ordered according to their causal priority. Under this assumption, there is a unique A which satisfies $A^{-1} (A^{-1})' = D$ for a given covariance matrix D .

For example, we can write 4 variable VAR system in vector form as

$$B_0 y_t = k + B_1 y_{t-1} + B_2 y_{t-2} + \dots + B_p y_{t-p} + \mu_t \quad (4.8)$$

$$\text{where } y_t = (R_t, M_t, P_t, Y_t)'$$

$$\mu_t = (\mu_{1t}, \mu_{2t}, \mu_{3t}, \mu_{4t})'$$

$$B_0 = \begin{bmatrix} 1 & -\beta_{12}^0 & -\beta_{13}^0 & -\beta_{14}^0 \\ -\beta_{21}^0 & 1 & -\beta_{23}^0 & -\beta_{24}^0 \\ -\beta_{31}^0 & -\beta_{32}^0 & 1 & -\beta_{34}^0 \\ -\beta_{41}^0 & -\beta_{42}^0 & -\beta_{43}^0 & 1 \end{bmatrix}$$

$$k = (k_1, k_2, k_3, k_4)'$$

and B_s is a (4×4) matrix whose row i , column j element is given by $-\beta_{ij}^s$

for $s = 1, 2, \dots, p$.

If each side of (4.8) is premultiplied by B_0^{-1} , the result is

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \dots + \Phi_p y_{t-p} + \varepsilon_t. \quad (4.9)$$

$$\text{where } c = B_0^{-1} k \quad (4.10)$$

$$\Phi_s = B_0^{-1} B_s \quad \text{for } s = 1, 2, \dots, p \quad (4.11)$$

$$\varepsilon_t = B_0^{-1} \mu_t. \quad (4.12)$$

Assuming that (4.8) is parameterized sufficiently richly that μ_t is vector white noise, then ε_t will also be vector white noise and (4.9) will be recognized as the vector autoregressive representation for the dynamic structural system(4.8). Thus, a VAR can be viewed as the

reduced form of a general dynamic structural model. In previous sections, we calculated the impulse response function as $\partial y_{t+s} / \partial \varepsilon_{jt}$ in (4.7) which describes the effect of an innovation in the j th variable on future values of each of the variables. According to (4.12), the VAR innovation ε_{jt} is a linear combination of the structural disturbances μ_t .

For example, it might turn out that

$$\varepsilon_{1t} = 0.1 \mu_{1t} - 0.2 \mu_{2t} - 0.3 \mu_{3t} - 0.4 \mu_{4t} .$$

so that if ε_{1t} turns out to be negative, it might reflect the effects of either μ_{2t} , μ_{3t} , μ_{4t} or any combination of these disturbances. Therefore, the impulse response function using VAR might not be interesting since ε_t represents any combination of the different influences that matter for the variables in the economy. This gives us the reason why we need to identify μ_{it} from ε_t .

In VAR system, for $\Omega = E(\varepsilon_t \varepsilon_t')$, we found a lower triangular matrix A and a diagonal matrix D such that $\Omega = ADA'$. We then constructed the vector $A^{-1} \varepsilon_t$ and calculated the consequences of changes in each element of this vector for future values of y_t . Recall from (4.12) that the structural disturbances μ_t are related to the VAR innovations ε_t by $\mu_t = B_0 \varepsilon_t$. Suppose that it happens to be the case that the matrix of structural parameters B_0 was exactly equal to the matrix A^{-1} . Then the orthogonalized innovations would coincide with the true structural disturbances $\mu_t = B_0 \varepsilon_t = A^{-1} \varepsilon_t$. Since A is lower triangular, this requires B_0 to be lower triangular.

For example, one might argue that prices respond to other economic variables only with a lag and that money and interest rates also influence income only with a lag. One might argue further that the interest rates affect desire money holding at the point of

time. These assumptions suggest ordering the variables as $y_t = (P_t, Y_t, R_t, M_t)'$ for which the structural model would be

$$\begin{aligned}
 \begin{bmatrix} P_t \\ Y_t \\ R_t \\ M_t \end{bmatrix} &= \begin{bmatrix} k_1 \\ k_2 \\ k_3 \\ k_4 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \\ \beta_{21}^0 & 0 & 0 & 0 \\ \beta_{31}^0 & \beta_{32}^0 & 0 & 0 \\ \beta_{41}^0 & \beta_{42}^0 & \beta_{43}^0 & 0 \end{bmatrix} \begin{bmatrix} P_t \\ Y_t \\ R_t \\ M_t \end{bmatrix} + \begin{bmatrix} \beta_{11}^1 & \beta_{12}^1 & \beta_{13}^1 & \beta_{13}^1 \\ \beta_{21}^1 & \beta_{22}^1 & \beta_{23}^1 & \beta_{24}^1 \\ \beta_{31}^1 & \beta_{32}^1 & \beta_{33}^1 & \beta_{34}^1 \\ \beta_{41}^1 & \beta_{42}^1 & \beta_{43}^1 & \beta_{44}^1 \end{bmatrix} \begin{bmatrix} P_{t-1} \\ Y_{t-1} \\ R_{t-1} \\ M_{t-1} \end{bmatrix} \\
 &+ \dots + \begin{bmatrix} \beta_{11}^p & \beta_{12}^p & \beta_{13}^p & \beta_{13}^p \\ \beta_{21}^p & \beta_{22}^p & \beta_{23}^p & \beta_{24}^p \\ \beta_{31}^p & \beta_{32}^p & \beta_{33}^p & \beta_{34}^p \\ \beta_{41}^p & \beta_{42}^p & \beta_{43}^p & \beta_{44}^p \end{bmatrix} \begin{bmatrix} P_{t-p} \\ Y_{t-p} \\ R_{t-p} \\ M_{t-p} \end{bmatrix} + \begin{bmatrix} \mu_t^p \\ \mu_t^y \\ \mu_t^r \\ \mu_t^m \end{bmatrix}
 \end{aligned} \tag{4.13}$$

Suppose there exists such an ordering of the variables for which B_0 is lower triangular.

Write the dynamic structural model (4.8) as

$$B_0 y_t = -\Gamma X_t + \mu_t \tag{4.14}$$

$$\text{where } -\Gamma [n \times (np+1)] \equiv [k \ B_1 \ B_2 \ \dots \ B_p]$$

$$X_t [(np+1) \times 1] \equiv \begin{bmatrix} 1 \\ y_{t-1} \\ y_{t-2} \\ \vdots \\ y_{t-p} \end{bmatrix}$$

Suppose that the disturbances in the structural equations are serially uncorrelated and uncorrelated with each other :

$$E(\mu_t \mu_\tau') = D \text{ for } t = \tau \tag{4.15}$$

$$0 \text{ otherwise,}$$

where D is a diagonal matrix.

The VAR is the reduced form of the dynamic structural model (4.9) and can be written as

$$y_t = \Pi' X_t + \varepsilon_t \quad (4.16)$$

$$\text{where } \Pi' = -B_0^{-1} \Gamma$$

$$\varepsilon_t = B_0^{-1} \mu_t$$

Letting Ω denote the variance-covariance matrix of ε_t , we get

$$\Omega = E(\varepsilon_t \varepsilon_t') = B_0^{-1} E(\mu_t \mu_t') (B_0^{-1})' = B_0^{-1} D (B_0^{-1})' \quad (4.17)$$

If the only restrictions on the dynamic structural model are that B_0 is lower triangular with unit coefficients along the principal diagonal and that D is diagonal, then the structural model is just identified. To see this, note that these restrictions imply that B_0^{-1} must also be lower triangular with unit coefficients along the principal diagonal. Given any positive definite symmetric matrix Ω , there exists a unique lower triangular matrix A with 1s along the principal diagonal and a diagonal matrix D with positive entries along the principal diagonal such that $\Omega = ADA'$. Thus, unique values B_0^{-1} and D of the required form can always be found such that satisfy (4.17). Moreover, any B_0 matrix of this form is nonsingular, so that Γ can be calculated uniquely from B_0 and Π as $\Gamma = -B_0 \Pi'$. Thus given any allowable values for the reduced form parameters (Π and Ω), there exist unique values for the structural parameters (B_0 , Γ and D) of the specified form, establishing that the structural model is just identified.

Since the model is just identified, full-information likelihood (FIML) estimates of (B_0 , Γ and D) can be obtained by first maximizing the likelihood function with respect to the reduced form parameters (Π and Ω) and then using the unique mapping from reduced form parameters to find the structural parameters. The maximum likelihood estimates of Π are found from OLS regressions of the elements of y_t on X_t , and the MLE of Ω is

obtained from the variance-covariance matrix of the residuals from these residuals. The estimates B_0^{-1} and D are then found from the triangular factorization of Ω .

2-2. Multi-Country SVAR Model

For estimation of liquidity effects by structural VAR system (SVAR), we use the three different models in Giannini (1992) which are the K-model, the C-model, and the AB-model. However, since our model failed to converge in the K-model and the C-model, here we report the results only with the AB-model. According to Giannini, AB-model is the most generalized one among those 3 models and it is defined as follow:

“ A, B are (n x n) invertible matrices³⁶

$$A(L) y_t = A \varepsilon_t$$

$$A \varepsilon_t = B e_t$$

$$\text{where } E(e_t) = [0] \text{ and } E(e_t e_t') = I_n.$$

The A matrix induces a transformation on the ε_t disturbances vector, generating a new vector ($A \varepsilon_t$) that can be conceived as being generated by a linear combination (through B matrix) of n independent (orthogonal) disturbances, which we will refer to as e_t .

From $A \varepsilon_t = B e_t$, $A(\varepsilon_t \varepsilon_t') A' = B(e_t e_t') B'$, $A \Sigma A' = B B'$.

For Σ known, this equation always imposes a set of $n(n+1)/2$ non-linear restrictions on the parameters of the A and B matrices, leaving overall $2n^2 - n(n+1)/2$ free element. ..”(p.5-6)

With the AB-model in Giannini, we construct the multi-country SVAR model. In previous section, we applied VAR model country by country and then estimated the relationship between the coefficients which represented the liquidity effect and CBI. However, since these coefficients came from the separate systems of each country, not from one system, it might be less meaningful to compare the coefficients of each country

³⁶ For the discussion on the size of matrix B, see Giannini, p.4~5.

in the view of econometrics. In SVAR system, since we can impose the restrictions on the system and also include more than one country in one model, it is possible to consider the interactions of the economies and so, the estimation results would be more useful to compare the coefficients of each country as long as the restrictions are reasonable.

Before we construct SVAR model, we need to restrict the number of countries in the model because our time series data are not long enough to include all 11 countries in one SVAR model. With 9 months lag in each variable and time series data for about twenty years, six country is the maximum number of countries we can include in modeling a 4 variable SVAR system. And since the SVAR does not impose any restrictions on the interaction between lag variables cross the countries or on the effects of past variables to present variables, we also need to choose sample countries as reasonable as possible.

Under these conditions, first we construct a 5-country SVAR model for the period of 1973-1989. These countries are U.S., Germany, Japan, France, and U.K. Because these countries are the five largest countries in the world economy, it is reasonable to assume that the economic variables and economic policies are not free from those of other countries with a lag, that is, for example, the income level of one country is affected by the economic variables like income or price level of other countries. Second, we construct a 6-European country SVAR model for the same period. These are Germany, France, U.K, Italy, Denmark, and Norway. We choose these 6 countries by the order in the size of trade. The amount of international trade of these countries are larger than any other European countries. Since these 6 countries are the biggest ones in economic power

in Europe and they are located nearby, we also assume that these countries have interactions in the economic policies and the economic variables among each other.³⁷

For the estimation, we use quarterly data as well as monthly data. Quarterly data are used here with the expectation that the model with quarterly data can reflect interactions in economic policies and variables across countries better than monthly data, since usually it takes time for economic variables of one country to affect other's economic policy or variables. We will report the results mostly with quarterly data because actually we found that there are little difference in results using different time frequency data.

We will use systems as (P, R, M, Y) , (R, M, P, Y) , and (Y, P, R, M) .³⁸ In (P, R, M, Y) system, for example, price levels of each country are determined only by past values of economic variables of the country and those of other countries. Interest rates, however, are determined not only by past values of economic variables of all countries in the model but by present value of price level of the country which is predetermined. Money aggregates are affected by present price level and the interest rate of the country with all past economic history of all countries in the model. Finally, the income level of the country is determined by the current value of other variables in the country and the past history of the economic variables of the country as well as those of other countries. Table 22 shows our over-identified structural VAR system in a 5 country model and Table 23 in a 6 country model.

³⁷ We estimated the relationship with 7 countries which include U.S into this 6 country model. We used 6-months lags because of the limitation of the data length. The results in 7 country model were very similar to the results we report.

Table 22. 5 country SVAR model (1973-1989)

	(P,R,M,Y)	(R,M,P,Y)	(Y,P,R,M)
U.S.	$R = 156.13P$ (2.57) $M = 1.125P - 1.10E-4R$ (0.038) (1.64E-4) $Y = -0.569P + 0.004R + 1.224M$ (5.85E-4)(2.33E-6)(2.18E-4)	$M = 0.003R$ (1.32E-4) $P = 0.003R + 0.156M$ (4.77E-5) (0.01) $Y = 0.004R + 1.224M - 0.569P$ (2.33E-6) (2.18E-4)(5.85E-4)	$P = 0.056Y$ (3.74E-3) $R = 43.791Y + 82.342P$ (0.67) (2.19) $M = 0.718Y - 0.224P - 0.014R$ (0.22) (0.06) (3.11E-4)
GER	$R = 211.55P$ (3.73) $M = -0.996P + 0.002R$ (0.09) (2.75E-4) $Y = 3.039P + 0.006R + 0.277M$ (0.13) (4.00E-4) (0.02)	$M = 2.38E-4R$ (2.10E-4) $P = 0.002R - 0.029M$ (3.55E-5) (2.60E-3) $Y = 0.006R + 0.277M + 3.039P$ (4.03E-4) (0.02) (0.13)	$P = 0.033Y$ (1.95E-3) $R = -3.033Y + 30.146P$ (0.44) (2.72) $M = 0.251Y - 2.465P - 0.021R$ (0.03) (0.16) (7.37E-4)
JAP	$R = 42.782P$ (1.16) $M = -0.748P - 0.006R$ (0.02) (2.32E-4) $Y = 0.404P + 0.003R - 0.005M$ (0.02) (1.93E-4) (0.01)	$M = -0.010R$ (2.33E-4) $P = 0.002R - 0.327M$ (1.62E-4) (0.01) $Y = 0.003R - 0.005M + 0.404P$ (1.93E-4) (0.01) (0.02)	$P = -0.037Y$ (3.84E-3) $R = 8.449Y + 38.582P$ (0.33) (1.07) $M = 0.079Y - 0.096P - 0.005R$ (0.02) (0.05) (5.44E-4)
FRA	$R = 213.66P$ (1.89) $M = 5.92P - 0.02R$ (0.11) (4.52E-4) $Y = 0.310P + 0.009R - 0.100M$ (1.70E-3)(6.67E-6)(1.85E-4)	$M = 1.42E-4R$ (2.91E-4) $P = 0.004R + 0.068M$ (2.41E-5) (1.30E-3) $Y = 0.009P - 0.100M + 0.310P$ (6.67E-6)(1.85E-4)(1.70E-3)	$P = -0.206Y$ (0.01) $R = 24.590Y + 11.323P$ (1.92) (3.02) $M = -1.074Y - 0.131P - 0.003R$ (0.08) (0.13) (5.39E-4)
U.K	$R = -12.614P$ (2.71) $M = -1.085P + 0.056R$ (0.10) (5.50E-4) $Y = -0.528P - 0.011R + 0.018M$ (0.01) (9.29E-5)(1.40E-3)	$M = 0.057R$ (5.57E-4) $P = 0.001R - 0.027M$ (1.60E-4) (2.40E-3) $Y = -0.011R + 0.018M - 0.523P$ (9.29E-5) (1.40E-3) (0.01)	$P = 0.008Y$ (4.30E-3) $R = 19.563Y + 90.778P$ (0.68) (1.95) $M = -0.140Y - 1.149P + 0.014R$ (0.04) (0.12) (4.28E-5)

Note : The standard errors are reported in parentheses

³⁸ We also construct 5-variable SVAR models which include commodity price in 5 country, 6 country, or 7 country 4-variable SVAR model but we do not report them here since the regression results regarding CBI do not have any significance.

Table 23. 6 country SVAR model (1973-1989)

	(P,R,M,Y)	(R,M,P,Y)	(Y,P,R,M)
GER	R = 11.739P (3.50) M = -0.292P - 0.004R (0.09) (3.85E-4) Y = 0.744P + 0.003R + 0.134M (0.06) (2.52E-4) (9.80E-3)	M = -0.004R (3.85E-4) P = 1.82E-4R - 0.008M (6.63E-5) (2.60E-3) Y = 0.003R + 0.134M + 0.744P (2.52E-4) (9.80E-3) (0.06)	P = 0.046Y (3.74E-3) R = 8.366Y + 5.609P (0.886) (3.527) M = 0.308Y - 0.508P - 0.005R (0.023) (0.089) (3.81E-4)
FRA	R = -31.469P (2.76) M = -3.112P + 0.008R (0.08) (4.27E-4) Y = 1.006P - 0.003R + 0.056M (0.05) (3.00E-4) (8.90E-3)	M = 0.011R (4.90E-4) P = -2.00E-5R - 0.085M (7.30E-5) (2.10E-3) Y = -0.003R + 0.056M + 1.006P (2.60E-4) (0.01) (0.05)	P = 0.089Y (4.56E-3) R = -8.061Y - 24.190P (0.894) (2.848) M = 0.161Y - 3.246P + 0.008R (0.026) (0.081) (4.29E-4)
U.K	R = 34.543P (1.99) M = 1.849P - 0.014R (0.10) (7.53E-4) Y = 0.269P - 0.004R + 0.042M (0.03) (1.89E-4) (3.70E-3)	M = -0.011R (7.55E-4) P = 0.002R + 0.038M (1.06E-4) (2.10E-3) Y = -0.004R + 0.042M + 0.269P (1.89E-4) (3.70E-3) (0.03)	P = 0.064Y (0.009) R = -27.151Y + 39.661P (1.091) (1.874) M = 0.702Y + 1.605P - 0.011R (0.061) (0.103) (7.93E-4)
ITA	R = 72.261P (1.89) M = 3.548P - 0.013R (0.07) (5.12E-4) Y = -0.817P + 0.007R + 0.242M (0.06) (3.37E-4) (9.30E-3)	M = -3.20E-4R (5.48E-4) P = 0.004R + 0.098M (7.40E-5) (2.00E-3) Y = 0.007R + 0.242M - 0.817P (3.37E-4) (0.01) (0.06)	P = 0.043Y (0.005) R = 8.221Y + 69.399P (0.654) (1.867) M = 0.552Y + 3.526P - 0.015R (0.021) (0.069) (4.85E-4)
DEN	R = 47.279P (3.09) M = 0.110P - 0.0113R (0.07) (3.31E-4) Y = -0.911P + 0.003R + 0.067M (0.03) (1.67E-4) (6.80E-3)	M = -0.011R (3.22E-4) P = 0.001R + 0.005M (7.99E-5) (3.30E-3) Y = 0.003R + 0.067M - 0.911P (1.67E-4) (6.80E-3) (0.03)	P = -0.159Y (0.006) R = 24.764Y + 66.625P (1.436) (3.185) M = 0.329Y + 0.407P - 0.012R (0.033) (0.074) (3.38E-4)
NOR	R = 11.496P (3.53) M = 0.990P - 0.007R (0.14) (5.77E-4) Y = 2.067P - 0.004R + 0.004M (0.05) (2.08E-4) (5.40E-3)	M = -0.007R (5.79E-4) P = 3.00E-4R + 0.012M (6.54E-5) (1.70E-3) Y = -0.004R + 0.004M + 2.067P (2.08E-4) (5.40E-3) (0.05)	P = 0.135Y (0.003) R = -21.222Y + 54.409P (1.022) (3.953) M = 0.030Y + 0.927P - 0.007R (0.043) (0.161) (6.04E-4)

Note : The standard errors are reported in parentheses

From the estimation results, we regress interest elasticity which is the coefficient of R in M equation on CBI. Regression results show no strong relationship between this elasticity and CBI although the coefficients of CBI for the liquidity effect have negative signs in all 3 cases. In the (Y,P,R,M) order, the relationship is significant at 1 percent level while in other two orders, it is not significant. But here, since we have only five countries in the model, it is not sufficient to interpret these results as the general relationship. In 6 country SVAR model which is reported in Table 18, we also find that the inverse relationship between CBI and the elasticity of interest rate but the relationship is not significant. However, since the elasticity of interest rates does not correspond to the liquidity effect, we need to calculate impulse response functions of the variables to the shock of each variable from this structural VAR model and examine the relationship between CBI and the impulse response functions which represent liquidity effects.

2-3. Estimation Results

Now, from these SVAR models, we can identify the impulse response function of the variables to the shock of each variable in the model which is $\partial y_{t+s} / \partial \mu_{jt}$.³⁹ Figure 24 and 25 depict the impulse response functions in 5-country and 6-country SVAR model respectively, which represent liquidity effects with (R,M,P,Y) order. From the impulse response functions, we obtain the same kinds of values as we used in previous sections and then regress these values on CBI measurement. The regression results are reported in

Table 24. In most cases, we get the expected relationships, which are inverse relationship between CBI and the contemporary, minimum or average liquidity effect and positive relationship between CBI and duration of liquidity effect. However, no relationship is significant and the $\bar{R}^2$ values are very small in most cases, so that it is very difficult to get implications from these regressions.⁴⁰

In SVAR model, we assume that economic variables or economic policy in one country are affected not only by past history of economic variables of the country but also by past history of economic variables or economic policies of the all other countries in the model. This assumption may not be reasonable since the economic authority would not consider past histories of all countries even though they might consider recent economic variables, or of the economic policies of some countries which have considerable effects on their economy. For example, Germany would not consider the past movements of economic variables or economic policies of small countries like Norway though small countries might consider the past movements of economic variables or economic policies of big countries. This unrealistic assumption in SVAR model could result in illogical impulse response functions of the variables and so the liquidity effect derived from these impulse response functions might not reflect the real relationship between money aggregate and interest rates. It, therefore, is very hard to find useful implications in the relationship between CBI and liquidity effect in SVAR model.

³⁹ We use VMA procedure for RATS in Giannini(p.122~127) to get the impulse responses in SVAR model.

⁴⁰ We also found no significant relationship between CBI and liquidity effects in 5-variable SVAR models.

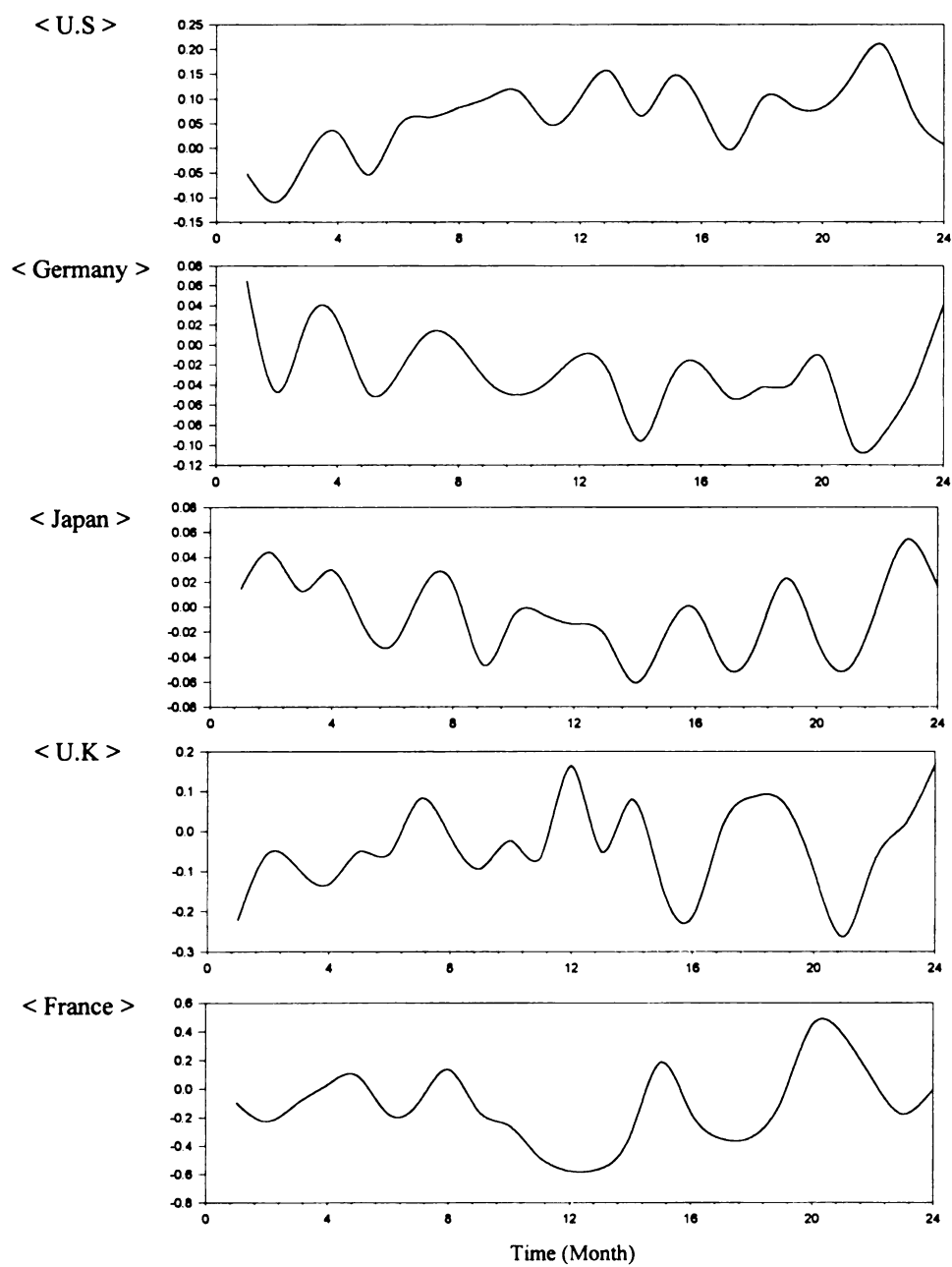


Figure 24. Liquidity Effects in 5-Country SVAR (R,M,P,Y)

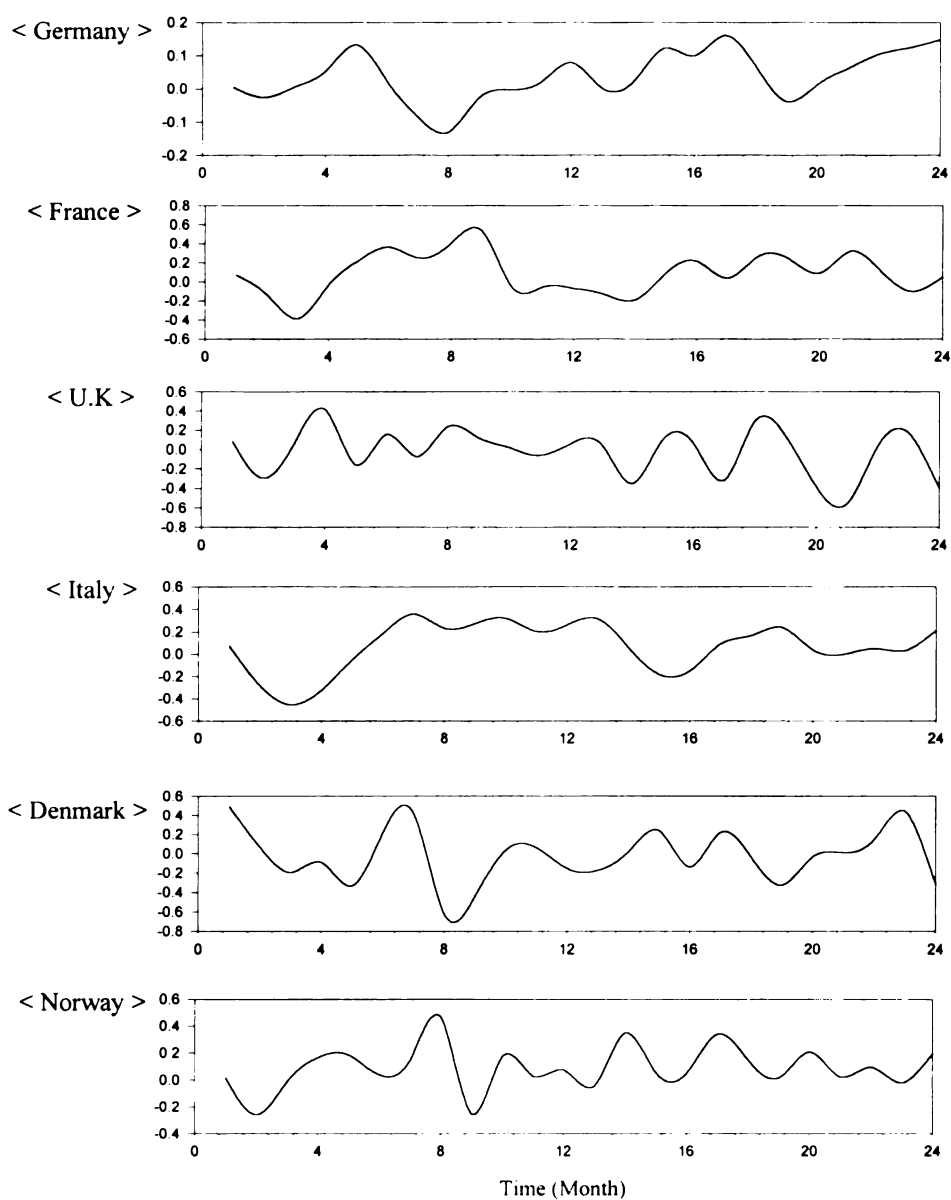


Figure 25. Liquidity Effects in 6-Country SVAR (R,M,P,Y)

Table 24. CBI and Liquidity Effects (SVAR)

		5-Country SVAR		6-Country SVAR	
		(R,M,P,Y)	(P,R,M,Y)	(R,M,P,Y)	(P,R,M,Y)
Contemporary Liquidity Effect	Intercept	0.174	0.245	0.266	0.126
	CBI	-0.061 (-1.19)	-0.078 (-0.92)	-0.747 (-1.13)	-0.785 (-1.06)
	R ²	0.32	0.22	0.24	0.22
Minimum Value of Liquidity Effect	Intercept	-0.128	-0.978	-0.678	-0.162
	CBI	-0.003 (-0.04)	0.248 (0.96)	0.771 (2.06)	-0.378 (-0.42)
	R ²	0.00	0.24	0.52	0.04
Average Liquidity Effect	Intercept	0.122	0.023	0.077	0.123
	CBI	-0.043 (-1.42)	-0.016 (-0.84)	0.129 (0.12)	-0.189 (-1.83)
	R ²	0.40	0.19	0.00	0.46
Duration of Liquidity Effect	Intercept	0.182	2.939	4.685	1.127
	CBI	1.364 (1.53)	0.879 (0.64)	-2.882 (-0.69)	4.357 (1.26)
	R ²	0.44	0.12	0.11	0.28

Note : The t-statistics are reported in parentheses

3. Summary

To complement the defects resulted from the traditional approaches, we adopted VAR system to identify the liquidity effects. First, we applied four variable nonstructural VAR approach to country by country to estimate the liquidity effect and then we examined the relationship between these liquidity effects and CBI. Applying VAR in our model did not change our previous results which came from the traditional empirical approaches. Liquidity effects are much stronger and more persistent in high CBI countries than in low CBI countries. It means that monetary policy effects are significantly affected by the degree of independence of the central bank. The difference in ordering of the variables also did not change the results.

Next, we added one more variable, commodity price, to the four variable VAR system to avoid price puzzle. The estimation results from this five variable VAR confirmed our previous results no matter which ordering was adopted. Finally, we constructed structural VAR model to get the more accurate impulse response functions and so the more accurate liquidity effects. And we included all countries considered in one SVAR model while we applied nonstructural VAR system country by country. The estimation results of this multi-country SVAR model revealed the inverse relationship between the liquidity effect and CBI as we expected. However, we did not find any significance in these estimated relationship. Even though the coefficients from the multi-country SVAR model are more meaningful for the comparison in the view of econometrics, this model has an illogical assumptions which are not suitable to the real economy. For example, a big country would not consider past histories of economy of other small countries as this model

assumed. Since the impulse response function from this multi-country SVAR model might be unreasonable in real world, our estimation results regarding the liquidity effect in this model have little policy implication.

CHAPTER V

CONCLUSION

Recent tendency toward reforming the central bank system to give more independence in many countries is primarily based on the success of the highly independent Bundesbank and Swiss National Bank in maintaining comparatively low rates of inflation for prolonged periods of time as well as the theoretical and empirical literatures which show the significant effect of CBI on inflation rates. After time consistency theory, many empirical researches have confirmed the theoretical arguments that greater central bank independence is associated with lower levels of inflation. Since political and economic dependence of central bank restrict the ability of the central bank to select its policy objectives without influences by the government and these dependence with high inflation experiences makes agents assign low credibility to the central bank's monetary policy, legal central bank independence has been identified with a credible commitment to the price stability. This credibility bonus is presumed to be the source of the negative correlation between central bank independence and inflation rates.

This study started from the idea that if independent central banks' policies are inherently more credible, not only inflation levels but also expectations of monetary policy must differ systematically across countries with differences in central bank independence. No studies have examined the postwar experiences for evidence of credibility effect of central bank independence until very recently, some studies tried to find the evidence. All of these studies regarding credibility effects, which are DeBelle

and Fischer (1994), Walsh (1994), and Posen (1995), adopted the idea that the greater credibility attributed to independent central bank should reduce the costs of subsequent policies to lower inflation and so examined the relationship between disinflationary costs and CBI. However, they found that disinflation appeared to be more costly and no more rapid in countries with more independent central banks.

Even though they have the same results, we should note some limitations in these studies before we accept their conclusion that there is no credibility effect of central bank independence. Because of data availability and CBI measurement problem for developing countries, they restrict the sample countries only to developed countries like most literature in this field. Since these developed countries usually have high independent central bank systems and have maintained relatively low inflation rates, the difference of CBI might not be sufficient to show the difference of disinflationary costs clearly. In addition, since central bank independence is negatively correlated with average inflation rates in these developed countries, the positive relationship between disinflationary cost and the independence level of central bank may reflect increasing marginal costs of disinflation. Therefore, their conclusion of no credibility effect of CBI should be interpreted very carefully and these limitations give us the necessity of further investigations for the credibility effect.

In this paper, we tried to find the credibility effect by directly examining the relationship between monetary policy effect and CBI. Our study is based on the assumption that the credibility effect can be shown in monetary policy effect on the economy and that higher central bank independence can make monetary policy effects stronger. This means that the degree of monetary policy effects can differ across

countries if their central banks have different level of independence. In order to measure monetary policy effects, we calculated liquidity effects in each country and then examined the relationship between central independence level and the size of liquidity effects.

When we applied the various traditional approaches to find liquidity effects in each country, the regression results confirmed that there was a strong relationship between CBI and liquidity effects. We could see CBI enhanced the degree of monetary policy effects across countries. Applying SURE to the traditional approaches to find liquidity effects in each country did not change our original results in traditional methods. The regression results showed the significant relationship between CBI and liquidity effects. Furthermore, the liquidity effect estimated by non-structural VAR also shows a significant negative correlation with CBI. However, on the contrary, we could not find any significant relationships between these two variables in either 4-variable or 5-variable SVAR model even though the signs of most coefficients are as we expected.

How should we interpret these contradictory results in SVAR model? Is this result strong enough to deny the preceding results which show a significant negative correlation between CBI and liquidity effects? In SVAR system, we assumed that economic policies or economic variables of each country are affected by past history of economic policies and economic variables of all countries in the model. Since we use quarterly data, this assumption means that economic policy authorities in each country get all information of past economic fluctuation and policy changes, including the previous quarter, of all other countries and consider all these information when they set their own economic policies.

However, in practice, there are much more considerable time lags to get the exact information of changes in economic variables of other countries and the economic policy

authorities might have not enough time to wait to get all information regarding economic changes in other countries for setting their own policy. For example, a country would need more than one time lag, which is 3 months in our model, to get the information about other countries' previous period income level. We do not know how many time lags should be needed for policy authority to get a specific information about the economic fluctuations in other countries. This implies that the estimated liquidity effects in SVAR model should be changed if we change our SVAR structure and that our estimated relationship between CBI and liquidity effect also might be changed. Simple change in lag structure in SVAR model should result in changes in estimated liquidity effect in the model. Practically, it would need huge matrix structures and more precise computational program to consider the case that a country needs different time lags to get the information of each economic variables of other countries. The problem in SVAR model is that we do not know the right structure of multi-country model even though SVAR model gives us an advantage in which we get the all countries' liquidity effects from one model structure, not from country-by-country models. Therefore, we need more future studies in constructing multi-country SVAR model.

Although the SVAR model did not support our previous results, this paper suggests that there is a significant relationship between CBI and liquidity effects and also that there is a vicious circle which shows us the inverse relationship between CBI and inflation rates if a low CBI country needs larger changes in monetary aggregates to affect interest rates which is suggested from the relationships between CBI and liquidity effects.

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