CHAPTER 2

Theoretical background and literature review

In this chapter educates the issue and the notion which relate to this study. This chapter is divided in to three parts. First part presents and discusses the theoretical framework that guide and inform this study, second part presents critical review of the literature that relate to this study and third part is assess Quantitative Easing policy of the United States.

2.1 Theoretical background

To educate the effect of Quantitative Easing to exchange rates, stock and bond market in TIP which consist of 2 parts. First part is a notion and theoretical of international mobility of capital and its impact on foreign financial market and second part is a notion and theoretical of econometric

2.1.1 A notion and theoretical of international mobility of capital and its impact on foreign financial market

2.1.1.1 Purchasing Power Parity (PPP)

Purchasing Power Parity (PPP) is theory of exchange rate determination. It asserts that exchange rate change between 2 currencies over any period of time is determined by change in 2 countries relative price level.

Assume that there are 2 countries, Let P_i and P_i^* represent the price of the amount of commodity at home and abroad, stated in home and foreign currency respectively, and r is exchange rate. Considering the connection between exchange rates and the local currency price of an individual commodity in home and aboard known as "the law of one price", abstracting from all and any frictions the price of given good will be the same in all locations when quoted in the same currency , $P_i = rp_i^*$.

Consider now a domestic price index $P = f(p_1,..., p_i,...p_n)$ and a foreign price index $P^* = f(p_1^*,..., p_i^*,...p_n^*)$. If the prices of each good are equal across 2 countries, and if the same good enter each country's market with the same weights (i.e. the homogenous of degree one g(.) and f(.) function are the same) then absolute PPP prevails. The law of one price in this special case extends not only the individual goods but also to aggregate price levels. Spatial arbitrage then takes the form of the strong or absolute versions of PPP:

$$r = \frac{p_i}{P^*} \tag{2.1}$$

where the right hand side is the common multiple of the price of each good in one currency and in the other (Dornbusch, 1985)

2.1.1.2 Interest Parity

Interest rate parity is the financial asset version of purchasing power parity. It defines a relationship among the domestic interest rate, foreign interest rate and the expected change in the exchange rate. This approach assumes that an agent is risk neutral and holds deterministic exchange rate expectations. Thus,

$$i_d = i_f + E(\Delta r_t) \tag{2.2}$$

where i_d is domestic interest rate, i_f is foreign interest rate and $E(\Delta r_t)$ is expected change in exchange rate. This equation is called uncovered interest parity (UIP) condition. However, in the normal case of agents who are risks averse and uncertain about the future value of exchange rate. Thus, rewriting the Eq.(2.2) as follows:

$$i_d = i_f + E(\Delta r_t) + \delta \tag{2.3}$$

where δ is the risk coefficient or risk premium which expresses in the proportional or percentage terms in the equation. This equation is called uncovered interest parity with risk premium.

2.1.1.3 Channels for International Portfolio Investment Approach (Bartram and Dufay, 1997)

1. Direct Foreign Portfolio Investment

1.1 Purchase of Foreign Securities in Foreign Markets.

The most direct way to implement international investment is the purchase of foreign securities directly in the respective local (foreign) market of the issuer. Foreigner investors could purchase foreign securities through banks and securities brokers, either in the domestic or foreign market. The purchase of foreign securities can be accomplished by opening an investor account with a brokerage firm aboard. The broker will buy the foreign securities on behalf of the investor and in turn change commissions for the handling of orders and the management of the account. Such non-resident accounts are similar to foreign funds which maintain in foreign country. These individual accounts have been used by citizens of emerging countries, who knew that the asset are uncertainty and depend on the movement of political fortune. Furthermore, an abolishment of international transactions in securities is a temporary occurrence.

National authorities are primarily interested in determining their internal economic affairs, even against market forces. However, transactions of foreign investors with other nonresidents do not adversely affect the internal economic conditions of the country concerned. On the contrary, the local financial community gain income, employment, and prestige, and afford the country a potential source of capital inflows.

However, trading and owning the securities of investors have several problems to them that are a high rate failures, unreliable interest and dividend payments, restrictions on foreign investment, foreign withholding taxes, capital controls, differences in accounting rules and reporting requirements and poor information flow. In or der to avoid these problems, investors might consider the purchase of foreign securities in the domestic market.

1.2 Purchase of Foreign Securities in the Domestic Market

In some countries, the possibilities exist to purchase foreign securities in the domestic market of investor. Foreign securities are available to the investor domestically, if the issuing corporation sells its securities not only in the market of the country where it is incorporated, but also in other markets. Such transactions are often accompanied by listing of the securities usually on one of the exchange of the country where the securities are placed. Normally, a minimum number of securities must be distributed among local investors as a requirement for listing, or alternatively the listing is a prerequisite for the successful placement of a substantial issue.

All national and international securities markets must deal with the need to organize the physical handling and delivery of traded securities efficiently. A system of depository receipts (DRs) has been created in most markets where transactions in foreign securities play a significant role. It represents a “receipt” issued by a domestic institution for a foreign security which is held in trust in its name abroad. The basic function of the Depository- company, bank and trust company, is to safeguard the original securities and issue negotiable instruments to the specific legal requirements of the investor.

The basic service of the depository company transforms the securities of the original market into negotiable instruments in order to the legal environment of the investor. It also take care of dividend collections, foreign exchange problem, handle right issues for investor, assist the investor in claiming the withholding tax credits and take care about securities information.

Besides the bank which issues the DRs and its related depository institution abroad, there is a large international broker-dealer which also play an important role in the purchasing process. they perform arbitrage by purchasing or selling the securities aboard, depositing or withdrawing from the issuing bank’s foreign depository in the return of the issuance or cancellation of DRs, whenever there is a sufficient difference between the price of DRs.

2. Indirect Foreign Portfolio Investment

2.1 Equity-linked Eurobonds

As it appear difficult to invest internationally by purchasing foreign securities directly because of burdensome procedures, lack of information, difference in accounting standards, low liquidity and limited choice of domestic foreign shares, Thus, indirect foreign portfolio investment represents an alternative strategy for investor. One way that has been proposed is the acquisition of securities whose value is closely linked to foreign shares such as equity-linked Eurobond. These are Eurobond with warrants and convertible Eurobonds. They represent a financial instrument that consists with a straight debt component and a call option on the foreign stock. There are depending on the movement of interest rate and development of underlying equity. These instruments can be the useful instruments for investor in order to invest in foreign securities.

2.2 Purchase of Shares of Multinational companies

The investor can access to shares of the foreign firms by purchasing a share of multinational companies. Thus they could accomplish international portfolio diversification themselves, and the present of the foreign securities by domestic firms would not provide benefits that could not obtain for them. Foreign assets and securities would be priced on the same grounds as domestic assts.

However, because of barriers of foreign investment, segmented capital markets could be a source of important advantages to multinational companies (MNCs). In particular, unlike expansion though domestic acquisitions, in many cases foreign acquisitions can add the value of the MNCs because a foreign asset may be acquired at the market value priced in the foreign market. The foreign asset has higher value if foreign investor are more risk adverse than domestic investor and foreign asset has less risky than domestic asset. Thus, some of foreign assets could add the wealth of the shareholders of the firm. As a rule, companies engaged in international business and foreign operation have a better access to foreign firms and securities than domestic investor. This suggests that such companies provide their domestic shareholders with the benefits of indirect international portfolio diversification.

2.3 International Mutual Funds

Investing in mutual fund solves the problem of individual investor to get the information about foreign companies and securities. The fund management company deal with the problem associated with foreign securities trading instead of individual investor. In return, investors have pay fees for the service of the fund and also management of portfolio. These are fund that specialized by commodity, industry, investment class, country and region. There are many international funds which invest in a aboard. Many domestic funds have an international component in the sense that they contain foreign securities. Finally, some global funds purchase foreign as well as stocks.

2.1.1.4 The effect of the exchange rate in stock market Approach

There are several ways in which the exchange rate can affect the stock market. First, a depreciating currency causes a decline in stock prices because of expectations of inflation (Ajayi and Mougoue, 1996 as cited in Dimitrova, 2005)

$$rer = \frac{r \times P^*}{P} \tag{2.4}$$

whereas

rer	=	the real exchange rate
r	=	the exchange rate
P	=	the domestic asset price
P^*	=	the foreign asset price

If the real exchange rate equals unity, the higher nominal exchange rate in the short run is consistent with a decrease in the ration P^* / P towards long run equilibrium. A lower P^* / P ratio implies the relative higher domestic price, Therefore, a depreciation of the nominal exchange rate creates the expectation of inflation. Inflation seems to be a negative shock in the stock market because it tends to restrict consumer spending and company earning.

Second, foreign investor will be unwilling to hold asset (i.e. stock) in currency that depreciates because it erodes the value of their portfolio. Thus, the investor have to refrain from holding the stock in currency that depreciates and sell their stock the stick price then ought to drop.

Third, the effect of exchange rate depreciation will be different for each company depending on whether it imports and exports more, whether it owns foreign units, and whether it hedges against exchange rate fluctuation. Heavy importer will suffer from higher cost due to weaker domestic currency and will have lower earning, thus the lower stock price. However, multinational companies that have hedged adequately will have not severe from exchange rate fluctuation, thus their stock price have not affected.

Lastly, depreciates of exchange rate will boost the export industry and depress the import industry. The impact on domestic output will be positive. Increasing output indicates in expansion of economy and tends to boost the stock prices.

Overall, the effect of exchange rates on stock prices is quite inconclusive as there is some support for both a positive and negative relationship. However, in the short run, it will be the expectations of investors that affect the stock market, rather than the fundamentals of the economy.

Base on the discussion above, the factors that influence stock prices as follows:

$$SP = f(\underset{+}{Y}, \underset{-}{INF}, \underset{-}{r}) \qquad (2.5)$$

whereas

Y	=	Gross domestic of Products
INF	=	inflation
r	=	exchange rate

2.1.1.5 Asset Stock Adjustment in partial Equilibrium Framework.

The central idea of the Tobin- Markowitz theory of portfolio equilibrium is that holders of financial wealth divide their wealth among the various assets on the basis of the yield and risk of the assets themselves. Suppose that the holders of wealth (W) have a choice between national money (L), national (N) and foreign bond (F); the exchange rate is assumed to be fixed. We get

$$L + N + F = W, \ \frac{L}{W} + \frac{N}{W} + \frac{F}{W} = 1 \qquad (2.6)$$

whereas $$\frac{L}{W} = h(i_d, i_f, y), \ \frac{N}{W} = g(i_d, i_f, y), \ \frac{F}{W} = f(i_d, i_f, y) \qquad (2.7)$$

where i_d and i_f are domestic and foreign interest rates respectively. These three function are depend on each other. It is then assumed that these functions have certain plausible properties. First of all, the fraction of wealth held in the form of money a decreasing function of the yields of both national and foreign bonds; an increase in i_d

and i_f decreases the effect on demand for money and expand the effect on the demand of money.

The fraction of wealth held in the form of domestic bond is an increasing function of i_d and decreasing function of i_f ,thus an increase in the foreign interest rate will induce the holder of wealth prefer foreign bonds. Similarly the fraction of wealth held in the form of foreign bond is an increasing function of i_f and decreasing function of i_d , Finally, the fraction of wealth held in the form of both domestic and foreign bond is a decreasing function of y .

In the case of implication of the small country, assumes that non-residents have no interest in holding bond o this country, so that capital outflows are come from the demand for foreign bond of residents and capital inflow from the supply for foreign bond.

Having this assumption, in the market equilibrium introduce demand function is always equal supply function which indicate by M for money; N^s for domestic bond and for foreign bond no symbol is needed as the hypothesis that their perfect elastic supply has always equals demand on the part of residents. That is

$$M + N^s + F = W \tag{2.8}$$

whereas

$$M = h(i_d, i_f, y)W,\ \ N^s = g(i_d, i_f, y)W,\ \ F = f(i_d, i_f, y)W = W \tag{2.9}$$

From Eq.(2.6) and Eq.(2.7), we obtain

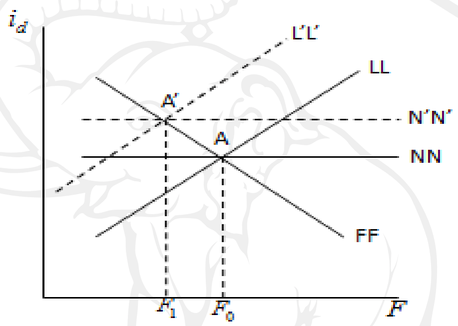
$$h(i_d, i_f, y)W,\ \ g(i_d, i_f, y)W,\ \ f(i_d, i_f, y)W = W \tag{2.10}$$

and so, subtracting Eq.(2.10) from Eq. (2.8), we obtain the formal of Walras's law, that is

$$[M - h(i_d, i_f, y)W],\ [N^s - g(i_d, i_f, y)W],\ = [F - f(i_d, i_f, y)W] = 0 \tag{2.11}$$

The system can be represent graphically. In Fig. 2.1, there are three schedules, LL,NN and FF, derived from Eq.(2.9) . The LL schedule represents the combination of i_d and F which has a positive relationship because an increase in foreign bond held by residents implies a decrease in the money stock (resident give up domestic money to the central bank in exchange for foreign money to buy foreign bond). Thus maintaining monetary equilibrium, central bank has to increase the i_d in order to absorb the domestic money.

The NN schedule represents the combinations of i_d and F which ensure the equilibrium in the domestic bond market. It is the horizontal line because whatever the amount of foreign bonds held by residents, domestic interest rates does not change. Finally, the FF schedule represents the combination of i_d and F which has negative relationship because an increase in domestic interest rate will decrease the resident's demand for foreign bond (resident will switch foreign bond to hold domestic bond in order to gain high return)



Source: Gandolfo, 2002

Figure 2.1 Monetary policy, portfolio equilibrium and capital flows

The three schedules initially intersect at the equilibrium at point A. If the central bank employs a monetary policy, it influences the interest rate indirectly, by acting on the stock of money. This action can effects in various ways, for example, central bank increase the supply domestic bonds, N^s. NN will shift parallel upwards to position $N'N'$ so, domestic interest rate is increase to induce the resident's demand of domestic bond in order to absorb the greater supply. Consequently, LL shifts upwards to the left, because of the supply of new bond, will reduce the money stock. While, the FF schedule remain unchanged because the exogenous variables has not changed.

The new point of equilibrium is A' which indicates that the domestic interest rate is higher than the initial equilibrium and the stock of foreign bonds (F_1) decrease to F_0 (capital inflow).

In conclusion, the supply of new domestic bonds will create an excess supply of bonds, so the price of domestic bond falls and thus the domestic interest rates which in inversely related to the price of bonds, increase until the demand for bonds increase to a sufficient to absorb the greater supply. As the bonds are sold by center bank in exchange for money, the stock of money, then, decrease. Besides, as increasing of domestic interest rate, it will lead to reduce in foreign bond.

2.2.1.6 The Modern Approach: Money and assets in Exchange Rate Determination.

The Modern approach provides 2 different approaches, the monetary approach and the portfolio approach. The monetary approach takes the exchange rate as the relative price of monies which assume perfect substitutability between domestic and foreign bonds, Conversely, the portfolio approach takes the exchange rate as the relative price of bond which assume imperfect substitutability.

1. The Monetary Approach

The modern monetary approach had extended the monetary approach to the balance of payment (MABP) which has developed from the Mundell's model in order to give the changes in the money-stock an importance in the context of different model based on a pure stock-adjustment behavior. According to the MABP, if one assume flexible exchange rate, it proposed

$$M = kpy, \quad M_f = k_f p_f y_f, \quad p = rp_f \tag{2.12}$$

where M is domestic money stock; M_f is foreign money stock; k is the reciprocal of the velocity of circulation of domestic money; k_f is the reciprocal of the velocity of circulation of foreign money; p is domestic price level, p_f is foreign price level; and r is exchange rate.

The first two equations express monetary equilibrium in home country and foreign countries, respectively and the last equation is the PPP equation. Under the flexible exchange rates, the exchange rate is as follow:

$$r = \frac{M}{M_f} \cdot \frac{k_f y_f}{ky} \qquad (2.13)$$

In this model, the exchange rate is the relative price of M and M_f However, The interest rate is not explicitly present but can be introduced by assuming that the demand for money in real terms is also a function of i, that is

$$M = pL(y,i), \quad M_f = p_f L_f(y_f, i_f), \quad p = rp_f \qquad (2.14)$$

therefore

$$r = \frac{M}{M_f} \cdot \frac{L_f(y_f, i_f)}{L(y,i)} \qquad (2.15)$$

where L and L_f is demand of money of domestic and foreign country, respectively. From Eq.(2.15) it can be clearly see that an increase in the domestic money stock lead to deprecation in the exchange rate, while an increase in nation income cause an appreciation, and increase in the domestic interest rate cause a depreciation. This conclusion, especially in the last two, are contrast with the traditional approach, where an increase in income tends to make the exchange rate depreciate, while an increase in the interest rate, by raising the capital inflow, tend to make the exchange rate appreciate.

However, these different conclusions are perfectly consistent with the conclusion of MABP. For instance, increasing income leads to increase the demand of money, so the central bank will try to reduce the absorption of money from the economy. As a result, balance of payment will surplus, thereby appreciating the exchange rate. If the u holds in this model, this appreciation will reduce the domestic price, raise the value of the real money-stock (M/p), and restores monetary long run equilibrium. In the case of increase in i, it has a similar explanation.

2. The Portfolio Approach

This approach is based on a model of portfolio choice between domestic and foreign assets. Asset holders will determine the composition of their bond portfolios that is the shares of domestic and foreign bond depends on the considerations of the risk and expected return. In the case of imperfect substitutability this relation become as an Uncover interest parity with risk premium that is

$$i_d = i_f + \tilde{r}/r + \delta \tag{2.16}$$

whereas

i_d	=	domestic nominal interest rate
i_f	=	foreign nominal interest rate
$\tilde{r}/r$	=	expected change in exchange rate
δ	=	risk premium

Hence, with imperfect substitutability a divergence exist between i_d and $i_f + \tilde{r}/r$. The extension of this divergence will determine the allocation of wealth (W) between national (N) and foreign (F) bonds. Gandolflo (2000) assume that the domestic bonds are held by residents, because the country is too small for its asset to be interest to foreign investor. The model can be extended to consider the general case and provided that residents of any country wish to hold a greater proportion of their wealth as domestics bond

Base on the assumption above, the wealth equation is

$$W = N^d + rF^d \tag{2.17}$$

where the demands are expressed, in accordance with portfolio selection theory as

$$\begin{aligned} N^d &= g(i_d - i_f - \tilde{r}/r)W, \\ rF^d &= h(i_d - i_f - \tilde{r}/r)W \end{aligned} \tag{2.18}$$

where $g(...) + h(...) = 1$. Imposing the equilibrium condition that the amounts demand should be equal to the given quantities of supply, we get

$$N^d = N^s,\ F^d = F^s \tag{2.19}$$

Then, substituting Eq.(2.19) into Eq.(2.18) and dividing the second by first equation, we obtain

$$\frac{rF^s}{N^s} = \rho(i_d - i_f - \tilde{r}/r) \tag{2.20}$$

where $\rho(...)$ denotes the ratio between the $g(...)$ and $h(...)$ functions. From the Eq.(2.20) , express the exchange rate as a function of the other variables

$$r = \frac{N^s}{F^s}\rho(i_d - i_f - \tilde{r}/r) \tag{2.21}$$

The basic idea behind all this is that the adjusting of exchange rate keeps the international asset markets in long run equilibrium. For instance, the central bank employs an expansion monetary policy, purchasing domestic bonds, in order to stabilizing the economy. Following that, private resident asset holders find themselves with excess supply of reserve money and the excess demand for bonds can be eliminate by a decline in domestic interest rate. This decline in domestic interest rates then induces resident asset holders to switch from domestics to foreign bonds. Because the supply of foreign bonds is assumed to be fix in short run, the increase in demand for foreign bonds put a downwards pressure on the domestic currency's value. Although the domestic currency's value and domestic interest rate both decline. There are a substation effect arising from lower domestic interest rates that induces resident asset holders to acquire more foreign bonds, increasing in supply of foreign bonds from aboard to domestic residents, cause an appreciation in the exchange rate. Now, residents will be hold a higher amount of foreign bonds, only if the domestic price that they have to pay for these bond is lower (appreciate currency). So, the value of $rF^d = rF^s$ remains unchanged, as it should remain, since all the magnitudes in the right hand side of Eq.(2.18) are unchanged, and the market for foreign assets remains in equilibrium ($F^d = F^s$) at the higher level of foreign bond and a lower level or exchange rate.

2.1.1.7 The Channels of Contagion

Understanding the channels through which shocks are transmitted across countries is the key issue for policymakers in order to solve the negative effects.There are several ways in which these channels can be categorized. Forbes (2001) provided 4 main channels of contagion that are trade, bank, portfolio investors and wake-up call.(Forbes, 2001)

1. Trade channel

Trade can cause contagion through 2 effects that are bilateral trade and completion in third markets (i.e. periphery economies). A crisis in one country can reduce their income, therefore it has to decrease demand for import from other countries through bilateral trade. However, because the crisis may cause depreciating in its currency, this can improve the country's relative export competitiveness in third markets. So, this channel plays an important role in transmitting crises.

2. Bank and Lending Institutions channel

One important financial channel for contagion is through banks and other financial intermediaries. A shock in one country can leads banks to reduce their supply of credit in other countries by reducing liquidity and raising the cost of credit (interest rate). This could occur in different ways. For example, A crisis in one country can be reduce in confident in the economy as well as the financial intermediaries. Then, individual withdraws the bank deposits because a weak in economy increase nonperforming loans and reduce asset values, and because a bank's holding of sovereign debt lose value. Therefore, These effects could force the bank to reduce the supply of credit to other countries in various ways: a contraction in direct, cross-broader lending by foreign bank; a contraction in local lending by the foreign bank' affiliates; and a contraction in lending by domestic banks resulting from the funding shock to their balance sheets from declines in interbank, cross-broader lending.

3. Portfolio Investors channel

An idiosyncratic shock to one country reduced the value of investor's portfolio, forcing them to sell assets in other countries to meet margin call or to rebalancing portfolio. An increasing in risk aversion after a negative shock of information asymmetries and imperfect information can cause sell asset across countries.

Cipriani, Gardenal and Guarino (2003) proposed that traders need to rebalance their portfolios; contagions arise even when traditional channels of contagion, such as correlated information, correlated liquidity shocks or wealth effect, are absent. For example, there are three assets traded in the economy, A,B and C, which are emerging, advanced and periphery economies ,respectively. These liquidation values take the form

$$V_A = \theta_A + \beta_A f_1 + \eta_A$$
$$V_B = \beta_{B,1} f_1 + \beta_{B,2} f_2 \qquad (2.22)$$
$$V_C = \theta_C + \beta_C f_2 + \eta_C$$

where f_1 and f_2 represent shared macroeconomic risk factors; β_A, β_B and β_C are the risk factor's marginal effects on the assets; θ_A and θ_C represent country-specific private information; and η_A and η_C are country-specific risk factors.

Note that countries A and C share no common macroeconomic factor. Moreover, they are not connecting either correlated information or shocks. Nevertheless, investors need to adjust their portfolio leads to shocks transmitting themselves from one economy to other economies. This happen because, although A and C share on risk factors, they are both linked to B, and B acts as channel for shock transmission. There are 2 types of traders in the markets that are informed and uninformed traders. Both type of traders trade in all markets. Let consider in informed traders first, there are N informed traders, who receive a perfect informative signal about the values of the three assets. Each informed trader choose the quantities of x_i^A, x_i^B and x_i^C to maximize the following payoff function:

$$(V^A - p^A)x_i^A + (V^B - p^B)x_i^B + (V^c - p^c)x_i^c - (x_i^A + x_i^B - R_1^*)^2 - (x_i^B + x_i^C - R_2^*)^2 \qquad (2.23)$$

whereas

x_i^J	=	the quantity of asset J , J=A,B,C
p^J	=	price of asset J, J=A,B,C
R_1^*	=	the optimal exposure to common risk factor to asset A and B
R_2^*	=	the optimal exposure to common risk factor to asset B and C

According to Eq.(2.23), the payoff function divides into 2 parts. First part contains the first three terms, call trading profit, which represent the gain made by trader i when buying or selling an asset. . The second part contains the last 2 terms; call Portfolio

Imbalance Penalty, which represent the penalty for holding an unbalance portfolio. In first term of this part, penalizes investor for excessive (or little) exposure to the risk factor common to A and B, whereas the second term penalizes investors for excessive(or little) exposure to the risk factor common to B and C

The Portfolio Imbalance Penalty is a reduced form way of adding portfolio balance considerations in the informed traders payoff function. As a result, trader's optimal demand does not depend on the expected value of an asset, but also on the optimal exposure to different risk factors.

On the other hand, considering the uninformed trader, they trade for price sensitive and liquidity reasons. Their aggregate net-supply schedule is price elastic, and given by

$$K^J[p^J - E(V^J)] \qquad (2.24)$$

where K^J is a positive parameter which measures how elastic the uniformed traders net supply function is change in the price. $E(V^J)$ represents the asset's unconditional expected value. Eq. (24) implies that uniformed traders sell the asset whenever Its price above the expected value and buy it whenever its price below the expected value.

One reason why uninformed trader's net supply is a price sensitive is asymmetric information in the markets because the degree of asymmetric information determines the severe contagion (Kodres and Pritsker, 2003 as cited in Cipriani, Gardenal and Guarino, 2013). In particular, if asymmetric information between informed and uniformed traders is severe, uniformed traders interpret the order flow in the market as having information content. Consequently, they respond more to change in the asset price because it effects their conditional expectation on the asset value. Moreover, the net supply function will be more elastic.

In each market, in equilibrium, net supply from the uninformed traders equal net demand form the informed trades

$$K^J[p^J - E(V^J)] = \Sigma_{i=1}^{N} x_i^J \qquad (25)$$

This means that the price in each market which inform traders face is

$$p^J = E(V^J) + \frac{1}{K^j}\Sigma_{i=1}^{N} x_i^J \qquad (26)$$

For instance, if the informed traders receive negative information shock, it makes them decrease their expected value in Market A . Their optimal response is to sell asset A, thus lowering their exposure to risk factor f_1 below the optimal level. Then they will buy an asset B, thus raising it price. This, however, increase s their exposure to risk factor f_2 above optimal level, thus leading them to sell asset C. As a result the price of asset C will fall, therefore, the negative shock in asset A leads to decrease in the price of asset A, increase in the price of asset B and decrease in the price of asset C. Moreover, informational asymmetry in Market B plays an important role in the transmission of the shock. If there is more information asymmetry in B, its price increase by more with the order flow and cross market rebalancing become more expensive thus, there are less rebalancing. In contrast, a decrease in informational asymmetry in market B makes contagion more severe.

4. Wake-up Call/Fundamentals Reassessment channel.

Finally, a mechanism by which contagion can occur is wake-up calls. Wake-up call could occur when investors were not focused on or aware of certain vulnerabilities and fundamental face with the severe problem during the crisis. For example, if a shock to banks in one country reduces funding for banks in other countries, this would be more likely to generate wake-up call and bank runs for a country with a weaker economy. The risk of these types of wake-up calls is also grater when there is more uncertainty, especially the fundamental or financial institution in the country

Theses wake- up calls can involve in many form of reassessment such as macroeconomic, financial market and political characteristics of the country, and the policy of international financial institutions. Chen (1999) shows that generous financial support for one country could be imply that the other countries might receive a few supports if a financial support package depletes a limited supply of funds. Any such reassessment of the functioning of financial markets or policies of international institutions could lead investor to sell asset across countries, thereby causing contagion.

The conclusion of a notion and theoretical of international mobility of capital and its impact on foreign financial market

There are many notions and theories which explain the dynamic relationship between U.S. Quantitative Easing monetary policy's spillover effects on Thailand, Indonesia, and Philippines(TIP). In the modern monetary approach, it had extended the monetary approach to the balance of payment (MABP) which has developed from the Mundell's model. This model assumes that there is imperfect substitutability between domestic and foreign bonds, so uncovered interest parity (UIP) with risk premium condition can hold in this model. When Federal reserve (Fed) employ an expansion a Quantitative Easing policy (QE), purchasing a domestic bonds (N), in order to stabilizing the economy. This implies an increase in domestic money stock (M) to the economy. In addition to an asset stock adjustment in partial equilibrium framework, the demand of domestic bonds (N) of Fed will create an excess demand of bonds, so the price of domestic bond increases and thus the domestic interest rates which in inversely related to price of bonds, decrease. Following that, in portfolio approach, the decline in domestic interest rates then induces domestic investors to switch from domestic to foreign bonds or other foreign assets through several channels because the lower in domestic interest rate could reduce the value of investor portfolios.

Cipriani, Garnenal and Guarino (2003) suggested that investors need to rebalance their portfolios in order to get the higher return. Whereas Bartram and Dufay (1997) purposed 5 main channels for international portfolio investment including purchasing foreign securities in foreign market, purchasing foreign securities in domestic market, purchasing securities whose value link to foreign asset, purchasing of shares of multinational companies, and investing international mutual fund. These channels allow domestic investors to switch from domestic bonds to foreign bond or other foreign assets. Consequently, as the supply of foreign bonds is assumed to be fixing in short run, the increase in demand for foreign bonds implies the capital outflow. Thus, from the monetary approach it can be clearly see that decrease the domestic money stock (M) lead to depreciation in the exchange rate.

Moreover, the depreciation in the exchange rate can affect the stock market in various ways. However, in the short run, I will be the expectations of investors that can affect the stock market, rather than the fundamentals of the economy. Therefore, a depreciation of the exchange rate creates the expectation of inflation, thereby, tending to restrict consumer spending and company earning. This seems to be a negative shock in the stock market. However in the long run, foreign investor will be unwilling to hold asset (i.e. stock) in currency that depreciates because it erodes the value of their portfolio. Thus, the investor have to switch from holding the stock in currency that depreciates to holding the stock in currency that appreciates (Ajayi and Mougoue, 1996 as cited in Dimitrova, 2005).

According to above, The U.S. Quantitative Easing monetary policy through purchasing of domestic bond, lead the domestic investors to rebalancing their portfolios through which purchase the foreign asset including foreign bond and stock markets. Moreover, these purchases of foreign asset imply a capital outflow which leads to lower the domestic exchange rate.

2.1.2 A notion and theoretical of econometric

2.1.2.1 Unit root test (Gujarati,2003)

A test of stationary or non-stationary is the unit root test. This study employ Dickey-Fuller(DF) and Augmented Dickey Fuller(ADF).

1. Dickey-Fuller Test (DF)

The actual process of implementing the DF test involves many decisions. The random walk process may have drift, no drift or it may have both deterministic and stochastic trends. To allow the various possibilities, the DF test is estimated in 3 different equations as follows:

Y_t is a random walk: $$\Delta Y_t = \alpha Y_{t-1} + u_t \tag{2.27}$$

Y_t is a random walk with drift: $$\Delta Y_t = \beta_0 + \alpha Y_{t-1} + u_t \tag{2.28}$$

Y_t is a random walk with drift and trend: $$\Delta Y_t = \beta_0 + \beta_1 t + \alpha Y_{t-1} + u_t \tag{2.29}$$

Where t is the time or trend variable; ΔY_t is the dependent variable in difference term; β_0 is the constant term; β_1 is the coefficient time trend (t); α is the coefficient of lagged value (Y_{t-1}); and u_t is error term. In each equation, the null hypothesis is that $\alpha = 0$, unit root (non-stationary in time series) while the alternative hypothesis is $\alpha \neq 0$ **,** no unit root (stationary in time series)**.** If the null hypothesis is rejected, it means that Y_t is a stationary time series.

The actual estimation procedure of these 3 equations is Ordinary Least Square (OLS) It can estimate the value of α and standard error. Comparing the result of t-statistic value with critical t-statistic value in the Dickey Fuller tables. If the value of t-statistic exceeds the DF t-statistic value, we can reject the null hypothesis, in which case the time series is stationary. On the other hand, if the value of t-statistic does not exceeds the DF t-statistic value we do not reject the null hypothesis, in which case the time series is non-stationary.

2. The Augmented Dickey-Fuller (ADF) Test

In conducting the DF test as in Eq.(2.27), Eq.(2.28), Eq.(2.29), it was assumed that the error term u_t was uncorrelated. But in this case, the u_t are correlated so Dickey and Fuller have been developed a test which extends from DF test, called The Augmented Dickey-Fuller (ADF) Test. This test augmented three equation of DF test by adding the lagged values of dependent variable ΔY_t that is autoregressive process. Therefore, The ADF test equation can be written as follows:

Y_t is a random walk: $$\Delta Y_t = \alpha Y_{t-1} + \sum_{i=2}^{p} \gamma_i \Delta Y_{t-i} + u_t \qquad (2.30)$$

Y_t is a random walk with drift: $$\Delta Y_t = \beta_0 + \alpha Y_{t-1} + \sum_{i=2}^{p} \gamma_i \Delta Y_{t-i} + u_t \qquad (2.31)$$

Y_t is a random walk with drift and trend: $$\Delta Y_t = \beta_0 + \beta_1 t + \alpha Y_{t-1} + \sum_{i=2}^{p} \gamma_i \Delta Y_{t-i} + u_t \qquad (2.32)$$

The number of lagged difference terms to include is often determined empirically, the idea being to include enough terms until the error term in these equations is no autocorrelation. In ADF test, it is follow the same asymptotic distribution as the DF statistic, so the same critical values can be used.

2.1.2.2 Vector Autoregression (VAR)

1. Reduced VAR

A simple vector model useful in modeling asset return is the vector autoregressive (VAR) model. Multivariate time series Y_t is a VAR process of order 1, or VAR (1) (lag1) for short, if it follows the model(tsay,2005).

$$Y_t = \phi_0 + \Phi Y_{t-1} + \varepsilon_t \tag{2.33}$$

where Y_t is vector of endogenous variable, ϕ_0 is a k-dimensional vector constant term, Φ is $k \times k$ matrix coefficient of Y_{t-1}, and $\{\varepsilon_t\}$ is a sequence of serially uncorrelated random vector with mean zero and covariance matrix(Σ)is required to be positive definite; otherwise, the dimension of Y_t can be reduced. In the literature, it is often assumed that ε_t is multivariate normal

Consider the bivariate case (i.e., $k = 2$, and $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t})'$). The VAR (1) model consists of the following 2 equations (k):

$$\begin{aligned} Y_{1t} &= \phi_{10} + \Phi_{11} Y_{1,t-1} + \Phi_{12} Y_{2,t-1} + \varepsilon_{1t}, \\ Y_{2t} &= \phi_{20} + \Phi_{21} Y_{1,t-1} + \Phi_{22} Y_{2,t-1} + \varepsilon_{2t}, \end{aligned} \tag{2.34}$$

Where Φ_{ij} is the $(i, j)th$ element of Φ and ϕ_{i0} is the ith element of ϕ_0. Based on the first equation, Φ_{12} denotes the linear dependence of Y_{1t} on $Y_{2,t-1}$ in the presence of $Y_{1,t-1}$. Therefore, Φ_{12} is the conditional effect of $Y_{2,t-1}$. If $\Phi_{12} = 0$,then Y_{1t} does not depend on $Y_{2,t-1}$, and the model shows that Y_{1t} only depends on its own past. Similarly, if $\Phi_{21} = 0$, then the second equation shows that Y_{2t} does not depend on $Y_{1,t-1}$ is given.

Consider the 2 equations jointly. If $\Phi_{12} = 0$ and $\Phi_{21} \neq 0$, then there is a feedback relationship between the 2 series. In general, the coefficient matrix Φ of VAR(1) measures the dynamic dependence of Y_t. The concurrent relationship between Y_{1t} and Y_{2t} is shown by the off-diagonal element σ_{12} of the covariance matrix Σ of a_t. If $\sigma_{12} = 0$,then there is no concurrent linear relationship between the 2 component series. In the econometric literature, the VAR(1) model is called a reduced form model because it does not show explicitly the concurrent dependence between the component series.

2. Lag length Criteria

There are several criteria that have been used determine the lag length in VAR model

2.1 Akaike Information Criterions (AIC)

The ideal of imposing a peanalty for adding regessors to the model has been carried further in the AIC, which is defined as:

$$AIC = e^{2k/n}\frac{\sum \hat{u}_i^2}{n} = e^{2k/n}\frac{RSS}{n} \qquad (2.35)$$

where k is the number of regressors (including the intercept), RSS is residual sum of square and n is the number of observations. In comparing two or more models, the model with the lowest value of AIC is preferred. AIC has been used to determine the lag length in VAR model.

2.2 Schwarz Information Criterion (SIC)

Similar in spirit of the AIC, the SIC criterion is defined as:

$$SIC = n^{k/n}\frac{\sum \hat{u}^2}{n} = n^{k/n}\frac{RSS}{n} \qquad (2.36)$$

Like AIC ,the lowest value of SIC is the best lag length for VAR.

2.1.2.3 Bayesian Inference

Conditional distributions play an important role in Gibbs sampling. In the statically literature, these conditional distributions are referred to as conditional posterior distributions because they are distributions of parameters given the data, other parameter values and the entertained model.

1. Posterior Distributions

Bayesian inference is an approach that combines prior belief with data to obtain posterior distributions on which statistical inference is based. It estimated maximizing the likelihood function of data in order to fit a model for make an inference model. (tsay, 2005)

Let θ be the vector of unknown parameters of an entertained model and X be the data. Bayesian analysis seeks to combine knowledge about the parameters with the data to make inference. Knowledge of the parameters is expressed by specifying a prior distribution for the parameters, which is denoted by $P(\theta)$. For a given model, denote the likelihood function of the data by $f(X|\theta)$. Then by the definition of conditional probability,

$$f(X|\theta) = \frac{f(X,\theta)}{f(X)} = \frac{f(X|\theta)P(\theta)}{f(X)} \quad (2.37)$$

where the marginal distribution $f(X)$ can be obtained by

$$f(X) = \int f(X,\theta)d\theta = \int f(X|\theta)P(\theta)d\theta \quad (2.38)$$

The distribution $f(X|\theta)$ is called the posterior distribution of θ. In general, we can use Bayes's rule to obtain

$$f(X,\theta) \propto f(X|\theta)P(\theta) \quad (2.39)$$

where $P(\theta)$ is the prior distribution and $f(X|\theta)$ is the likelihood function. Therefore, posterior distribution depends on prior distribution and the likelihood function.

2. Prior Distribution

In Bayesian statistic inference, there are many types of prior distribution of the parameter, called hyper-parameter. It is often based upon assessment of an experience expert of researcher. However, some will choose a conjugate prior which has the same distributional family as posterior distribution. A proper MS-BVAR analysis will incorporate the prior distribution to support inference the true value of the parameters.

In this study, I offer 3 different priors which have been popular in Bayesian statistic.

2.1 Normal-Wishart prior

When the assumption that $\Sigma_{\in}$ is loosened, a prior for the residual covariance can be also chosen. One well-Known conjugate prior for normal data is normal- Wishart:

$$\theta \sim N\left(\theta_0, \Sigma \otimes V_0\right)$$

where $\theta = \mu_1 i_{mp}$ is the coefficient mean and $\Sigma \otimes V_0 = \lambda_1 I_m$ is the coefficient covariance with 2 prior hyper-parameter μ_1 and λ_1, and

$$\Sigma_{\in}^{-1} \sim W(v_0, S_0^{-1})$$

where $v_0 = m$ is the degree of freedom and $S_0 = I_m$ is the scale matrix ($S_0 > 0$). Any values for the hyper-parameter can be chosen, however, it is worth nothing that non-informative prior is obtained by setting the hyper –parameter as $V_0 = v_0 = S_0 = cI$ and letting $c \to 0$. It can be seen that the non-informative prior leads to a posterior based on Ordinary Least Square (OLS) quantities which are identical to classical VAR estimation results.

According to the Bayes rule, the posterior becomes

$$\theta \sim N\left(\bar{\theta}, \Sigma \otimes \bar{V}\right)$$

And

$$\bar{\Sigma} \sim W(\bar{v}, \bar{S}_0^{-1})$$

Where

$$\bar{V} = [V_0^{-1} + X^{'} X]^{-1} \tag{2.40}$$

$$\bar{\theta} = \bar{V}[V_0^{-1}\theta_0 + X^{'} X \hat{\theta}]^{-1} \tag{2.41}$$

with the standard OLS estimate $\hat{\theta}$ and

$$\bar{v} = v_0 + T \tag{2.42}$$

$$\bar{S} = S + S_0 + \hat{\theta}^{'} X^{'} X \hat{\theta} + \theta_0^{'} V_0 \theta_0 - \bar{\theta}^{'} (V_0^{-1} + X^{'} X) \bar{\theta} \tag{2.43}$$

Since the natural conjugate have the same distributional form the prior, likelihood, and posterior. The prior can be considered as dummy observations.

2.2 Sim-Zha normal-flat prior

The normal-flat prior is a weak conjugate prior which has no meaningful prior information on the covariance matrix Σ_{ϵ}

$$\Sigma_{\epsilon} \propto \left|\Sigma_{\epsilon}\right|^{-(m+1)/2}$$

After some mathematical calculation, the posteriors are derived as

$$\Sigma_{\epsilon} = T^{-1}(Y - X\bar{\theta})^{'}(Y - X\bar{\theta}) \qquad (2.44)$$

whereas the coefficient parameter θ is derived by the rule in

$$\bar{\theta} = (I \otimes X^{'}X + H_0^{-1})^{-1}((I \otimes X^{'}Y)a_0 + H_0^{-1}\theta_0) \qquad (2.45)$$

2.3 Flat prior

One of the most common prior is the flat prior where the prior is simply a constant,

$$p(\theta) = k = \frac{1}{b-a} \qquad for\ a \le \theta \le b \qquad (2.46)$$

This conveys that it has no a priori reason to favor any particular parameter value over another. With a flat prior, the posterior just a constant times the likelihood,

$$p(\theta|x) = C\ell(\theta|x) \qquad (2.47)$$

In many case, classical expressions from frequents statistics are obtained by Bayesian analysis assuming a flat prior. If the variable of the interest ranges over $(0,\infty)$ or $(-\infty,+\infty)$, then strictly speaking a flat prior does not exists, as if the constant takes on any non-zero value, the integral does not exist. In such cases a flat prior (assuming $p(\theta|x) \propto \ell(\theta|x)$ is referred as an improper prior.

2.1.2.4 Bayesian Analysis via Gibbs Sampling

For the Bayesian inference of the model, given appropriate priors we need the marginal posterior distribution. The hierarchical nature of the model allow to employ Gibb sampling in obtaining the marginal posterior distribution(Tsay, 2004).

Gibbs sampling (or Gibbs sampler) of German and Geman (1984) and Gelfand and Smith (1990) is perhaps the most popular Markov Chain Monte Carlo (MCMC) which enable to make some statically inference that was not feasible. Assume that there are 3 parameters in this model. A missing data point can be regarded as a parameter under the MCMC framework. Similarly, an unobservable variable such as the "true" price of and asset can be regarded as N parameters when there N transaction prices available. This concept of parameter is related to data augmentation and becomes when discuss application of the MCMC methods.

Denote the three parameters, by θ_1, θ_2 and θ_3. Let Y be the collection of available data and M the entertained model. The goal here is to estimate the parameters so that the fitted model can be used to make inference. Suppose that the likelihood function of single parameter given the others is available. In other word, assume that the following 3 conditional distributions are known:

$$P_1(\theta_1 | \theta_2, \theta_3, Y, M),\quad P_2(\theta_2 | \theta_3, \theta_1, Y, M),\quad P_3(\theta_3 | \theta_1, \theta_2, Y, M),$$

where $P_i(\theta_i | \theta_{j \neq i}, X, M)$ denotes the conditional distribution of the parameter θ_i given data, the model, and the other 2 parameters. What is need is the ability to draw a random number from each of the 3 conditional distributions.

Let $\theta_{2,0}$ and $\theta_{3,0}$ be 2 arbitrary starting values of θ_2 and θ_3. The gibbs sampler proceed as follows:

1. Draw a random sample from $P_1(\theta_1 | \theta_{2,0}, \theta_{3,0}, Y, M)$. Denote the random draw by $\theta_{1,1}$

2. Draw a random sample from $P_2(\theta_2 | \theta_{3,0}, \theta_{1,1}, Y, M)$. Denote the random draw by $\theta_{2,1}$

3. Draw a random sample from $P_3(\theta_3 | \theta_{1,1}, \theta_{2,1}, Y, M)$. Denote the random draw by $\theta_{3,1}$

This completes a Gibb iteration and the parameters become $\theta_{1,1}, \theta_{2,1}$ and $\theta_{3,1}$.

Next, using the new parameters as starting values and repeating the prior iteration of random draws, complete another Gibbs iteration to obtain the updated parameters $\theta_{1,2}$, $\theta_{2,2}$ and $\theta_{3,2}$. Repeating the previous iterations form times to obtain a sequence of random draws:

$$(\theta_{1,1},\theta_{2,1},\theta_{3,1}),....,(\theta_{1,m},\theta_{2,m},\theta_{3,m})$$

Some regularity conditions, it can be shown that, for a sufficiently large m, $(\theta_{1,m},\theta_{2,m},\theta_{3,m})$ is approximately equivalent to a random draw from the joint distribution $P(\theta_1,\theta_2,\theta_3|Y,M)$ of 3 parameters. The regularity conditions are weak; they essentially require that for an arbitrary starting value $(\theta_{1,0},\theta_{2,0},\theta_{3,0})$ the prior Gibbs iterations have a chance to visit the full parameter space. The actual convergence theorem involves using the Markov chain theory.

In practice, a sufficient large n random sample from the joint distribution $P(\theta_1,\theta_2,\theta_3|Y,M)$, they can be used to make inference. For example, a point estimate of θ_i and its variance are

$$\hat{\theta}_i = \frac{1}{n-m}\sum_{j=m+1}^{n}(\theta_{1,j}-\theta_{2,j}),\ \ \hat{\sigma}_i^2 = \frac{1}{n-m-1}\sum_{j=m+1}^{n}(\theta_{1,j}-\theta_{2,j}-\hat{\theta})^2 \qquad (.248)$$

Gibbs sampling has the advantage of decomposing a high-dimensional estimation problem into several lower dimensional ones via full conditional distribution of the parameters. At the extreme, a high dimensional problem with N parameters can be solved iteratively by using N univariate conditional distributions. This property makes the Gibbs sampling simple and widely applicable. However, it is often not efficient to reduce all the Gibbs draws to them jointly. Consider the three-parameter illustrative example. If θ_1 and θ_2 are highly correlated, then one should employ the conditional distributions $P(\theta_1,\theta_2|\theta_3 Y,M)$ and $P_3(\theta_3|\theta_1,\theta_2,Y,M)$ whenever possible. A Gibbs iteration then consists of (a) drawing jointly (θ_1,θ_2) given θ_3 and (b) drawing θ_3 given θ_1,θ_2. For more information on the impact of parameter correlations on the convergence rate of a Gibbs samplers

2.1.2.5 Multi-Move Gibbs Sampling of Regimes

Krolzig (1997) derived the algorithm for multi-move Gibbs sampling. It is shown that the conditional posterior distribution of regimes involves the smoothed regime probabilities $\tilde{S}_t \left| T\right.$. Therefore, the Gibbs cycle is closely related to EM algorithm for ML estimation because it makes use of the same filtering and smoothing procedures.

1. Filtering and Smoothing Step

In this section, generates all the states at once by taking advantage of the structure of the Markov chain,

$$\Pr(S_t \left| Y_T\right.) = \Pr(S_t \left| Y_T\right.) \prod_{t=1}^{T-1} \Pr(S_{t+1} \left| Y_T\right.) \qquad (2.49)$$

Eq.(2.49)is derived for the conditionally normally distributed state variables. Thus to generate S_t from posterior $\Pr(S \left| Y_T\right.)$, we first draw S_t from $\Pr(S_t \left| Y_T\right.)$ that is yhe smooth full-sample probability distribution which can derived with the BLHK filter. Then $S_t, t = T-1, ..., 1$ is generate from $\Pr(S_t \left| S_{t+1}, Y_T\right.)$

In the smoothing algorithm, given the distribution $\Pr(S_t \left| S_{t+1}, Y_T\right.)$ $= \Pr(S_t \left| S_{t+1}, Y_t\right.)$ and, thus, can be deduced form

$$\Pr(S_t \left| S_{t+1}, Y_t\right.) = \frac{\Pr(S_t, S_{t+1} \left| Y_t\right.)}{\Pr(S_{t+1} \left| Y_t\right.)} = \frac{\Pr(S_{t+1} \left| S_t\right.) \Pr(S_t \left| Y_t\right.)}{\Pr(S_{t+1} \left| Y_t\right.)} \qquad (2.50)$$

In matrix notation Eq.(2.50) yields:

$$\tilde{S}_t \left| S_{t+1}, Y_T\right.) = [\mathrm{P}(S_{t+1} \otimes \tilde{S}_{t+1|t})] \odot \tilde{S}_{t|t} \qquad (2.51)$$

where $\odot$ and $\otimes$ denote the element-wise matrix multiplication and division respectively. The exception that the generate S_{t+1} is used instead of the smoothed probabilities $\tilde{S}_{t+1|T}$. Eq.(2.51) works analogously to the smoothing procedure involved in the EM algorithm of ML estimation.

To summarized, in the Gibbs cycle the generation mechanism of regimes is given by the following iterations

$$S_T \leftarrow \tilde{S}_{T|T} \tag{2.52}$$

$$S_t \leftarrow \tilde{S}_T \,|\, S_{t+1}, Y_T, \quad t = T-1,....,1, \tag{2.53}$$

where $\tilde{S}_{T|T} = \begin{bmatrix} \Pr(S_T = l_1 | Y_T) \\ \vdots \\ \Pr(S_T = l_{1M} | Y_T) \end{bmatrix}$ and $\tilde{S}_T \,|\, S_{t+1}, Y_T = \begin{bmatrix} \Pr(S_T = l_1 | S_{t+1}, Y_T) \\ \vdots \\ \Pr(S_T = l_{1M} | S_{t+1}, Y_T) \end{bmatrix}$

Denote that the probability distribution of S_t conditional on the previous drawn regime vector S_{t+1} and the sample information Y_T. To ensure identification at the determination of the conditional probability distributions of the transition and regime dependent parameters, a sample can be accepted only if it contains at least one draw of each regime.

2. Stationary Probability Distribution and Initial Regimes

In contrast to the handling of initial of Markov chain in the EM algorithm of maximum likelihood estimation. Assuming that the regime in $t = 0,...,1-p$ are generated from the same Markov process as the regimes in the sample $t = 0,...,1-T$. Moreover, assuming that the Markov process is ergodic, there exists a stationary probability distribution $\Pr(S_t | \rho)$, where the discrete probability can be included in the vector $\bar{S} = \bar{S}(\rho)$. Irreducibility ensures that the ergodic probabilities are strictly positive, $\bar{S}_m > 0$ for all $m = 1,..., M$. Consequently, generates S_0 from the stationary probability distribution

$$S_0 \leftarrow \bar{S}(\rho)$$

The estimation procedures established there are unaltered whether the singles-move or the multi-move Gibbs sampler is used for drawing the state vector S $(\bar{S})$.

2.1.2.6 Markov Switching Bayesian Vector Autoregressive (MS-BVAR)

The MSBVAR model is estimated using block EM algorithm where the blocks are Bayesian Vector Autoregressive (BVAR) regression coefficients for each regime (separating for intercepts, AR coefficient, and error covariance) and transition matrix (Nason and Tallman, 2013).

1. Model specification

Sim, Waggoner, and Zha (2008) provided tools to estimate and conduct inference on MS-BVAR models of lag length k as follow:

$$Y_t^{'} A_0(s_t) = \sum_{j=1}^{k} Y_{t-j}^{'} A_j(s_t) + C(s_t) + \varepsilon_t^{'} \Gamma^{-1}(s_t), \quad t = 1, ..., T \tag{2.54}$$

whereas	$Y_t^{'}$	=	n –dimensional column vector of endogenous variables
	A_0	=	n×n non singular matrix
	s_t	=	h dimension vector of regimes
	h	=	the finite set of integers H
	A_j	=	n×n matrix
	C	=	Vector of intercept terms
	ε_t	=	the vector of n unobserved shocks
	Γ	=	n×n diagonal matrix of the elements of ε_t

Key distributional assumptions made by Sim, Waggoner, and Zha include those on the densities of the MS-BVAR disturbances.

$$P(\varepsilon_t \mid Z_{t-1}, S_t, \omega, \Theta) = N(\varepsilon_t \mid 0_{n\times 1}, I_n) \tag{2.55}$$

And on the information set

$$P(Y_t | Y_{t-1}, S_t, \omega, \Theta) = N(Y_t | u_z(s_t), \Sigma_z(s_t)) \quad (2.56)$$

where $Y_t = [Y_1^{'}, Y_2^{'}, ...Y_t^{'}]$, $S_t = [S_0^{'}, S_1^{'}.....S_t^{'}]^{'}$, ω is vector of probabilities attached to the Markov chain,

$$\Theta = [A_0(1)A_0(2)....A_0(h), A(1)A(2)....A(h), C(1)C(2)....C(h), \Gamma(1)\Gamma(2)....\Gamma(h)]^{'} \quad (2.57)$$

$$A(\cdot) = [A_1(\cdot)\, A_2(\cdot)...A_k(\cdot)], u_z(\cdot) = [A(\cdot)\, C(\cdot)]A_0^{-1}(\cdot)[Y_t 1]^{'} \quad (2.58)$$

$$\Sigma_z(\cdot) = [A_0(\cdot)\Gamma(\cdot)^2 A_0^{'}\Gamma(\cdot)]^{-1} \quad (2.59)$$

Then, limiting MS to the diagonal matrix $\Gamma(S_t)$ that scales the volatility of the BVAR shock innovations (ε_t). The impact matrix A_0 the coefficient matrices $A_1, A_2, ...A_{(k)}$, and the intercept vector C are unchanged across regimes, which restrict the MS-BVAR dynamics to be constant across regimes. These restrictions yield the MS-BVAR(p)

$$Y_t^{'} A_0 = \sum_{j=1}^{k} Y_{t-j}^{'} A_j + C + \varepsilon_t^{'} \Gamma^{-1}(s_t), \quad (2.60)$$

Estimated for this paper, where Θ is modified to $[A_0 A_0 ....A_k(h) C\ \Gamma(1)\Gamma(2)....\Gamma(h)]^{'}$.

Sim, Waggoner, and Zha (2008) provide a distributional assumption with densities of the MS-BVAR disturbances as follows

$$P(\varepsilon_t | Z_{t-1}, S_t, \omega, \Theta) = N(\varepsilon_t | 0_{n\times 1}, I_n) \quad (2.61)$$

and on the information set

$$P(Y_t | Y_{t-1}, S_t, \omega, \Theta) = N(Y_t | u_z(s_t), \Sigma_z(s_t)) \quad (2.62)$$

where $Y_t = [Y_1^{'}, Y_2^{'}, ...Y_t^{'}]$, $S_t = [S_0^{'}, S_1^{'}.....S_t^{'}]^{'}$, ω is vector of probabilities which estimate by Markov chain,

$$\Theta = [A_0(1)A_0(2)....A_0(h), A(1)A(2)....A(h), C(1)C(2)....C(h), \Gamma(1)\Gamma(2)....\Gamma(h)]^{'} \quad (2.63)$$

$$A(\cdot) = [A_1(\cdot)\, A_2(\cdot)...A_k(\cdot)], u_z(\cdot) = [A(\cdot)\, C(\cdot)] A_0^{-1}(\cdot)[Y_t\, 1]' \tag{2.64}$$

$$\sum_z(\cdot) = [A_0(\cdot)\Gamma(\cdot)^2 A_0^{'}\Gamma(\cdot)]^{-1} \tag{2.65}$$

$$Q = \begin{bmatrix} \rho_{11} & \cdots & \cdots & \rho_{1h} \\ \vdots & \rho_{22} & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{n1} & \cdots & \cdots & \rho_{nh} \end{bmatrix} \tag{2.66}$$

The matrix Q given in Eq.(2.66) contains set of transition probability dynamics which has estimated by The MS-BVAR model, prior, and data. Suppose $h = 3$, the set of transition probabilities events would occur in the early, middle, and later parts of sample.

The likelihood of the MS-BVAR model is built by Y_t and assumptions Eq.(2.61), Eq.(2.62),Eq.(2.63), Eq.(2.64) and Eq.(2.65).

$$\ln P(Y_t \mid \alpha_t, \omega, \Theta) = \sum_{t=1}^{T} \ln[\sum_{S_t \in H} P(Y_t \mid \alpha_t, \omega, \Theta) P(S_t \mid \alpha_t, \omega, \Theta)] \tag{2.67}$$

where $P(Y_t \mid \alpha_t, \omega, \Theta)$ is the density used to sample the probability that S_t is in regime l given $S_{t-1} = j$ .Sim, Waggoner, and Zha (2008) also proposed Gibb sampling methods to construct the log likelihood(9) along with conditional densities of $\Theta, P(\Theta \mid \alpha_{t-1}, S_t, \omega)$ and $\omega, \omega, P(\Theta \mid \alpha_{t-1}, S_t, \Theta)$ whereas the vector of regimes S_T is integrated out of the log likelihood.

Esitimation of The MS-BVAR model Eq.(2.54) depends on the joint posterior distribution of Θ and ω. This posterior is calculated in the MS-BVAR model Eq.(1) using Bayes'rule, which gives

$$P(\omega, \Theta \mid Y_T, \alpha_T, \omega, \Theta) \propto P(Y_t \mid \alpha_t, \omega, \Theta) P(\omega, \Theta) \tag{2.68}$$

where $P(\omega, \Theta)$ denotes the prior of ω and Θ .

2. Particular MS-BVAR Process

The MS-BVAR model allows for the great variety of specifications. In principle, it would be possible to make all parameters regime-dependent and introduce separate regimes for each shifting parameter. But, this would be no practicable solution as the number of parameters of the Markov chain grows quadratic in the number of regimes and coincidently shrinks the number of observations useable for the estimation of the regimes-dependent parameter. For these reason a specific to general approach may be preferred for determination of the regime generating process by restricting the shifting parameters to a part of the parameter vector and to have identical break points.

In empirical research, only some parameters will be conditioned on the state of Markov chain while the other parameter will be regime invariant. In order to establish a unique notation for each model, Krolzig (1997) specify with the general MS(M) term the regime-dependent parameters:

M Markov-switching mean

I Markov-switching intercept term

A Markov-switching autoregressive parameters

H Markov-switching heteroskedasticity

2.1.2.7 Comparison of multiple change-point model via the marginal likelihood

Within the Bayesian framework, the Bayes factors have been widely used for the model comparison. The calculation of the marginal likelihood using the posterior simulation output has been an area of much current activity. A method developed by Chip (1995) is particularly simple to implement. The key point is that the marginal likelihood of Model M_i

$$m(Y_n \middle| M_i) = \int f(Y_n \middle| M_i, \Theta, P)\pi(\Theta, P)M_i)d\psi \tag{2.69}$$

May be re-express as

$$m(Y_n \middle| M_i) = \frac{f(Y_n \middle| M_i, \Theta^*, P^*)\pi(\Theta^*, P^*)M_i)}{\pi(\Theta^*, P^*)\middle| Y_n M_i)} \tag{2.70}$$

where (Θ^*, P^*) is any point in the parameter space and $f(Y_n | M_i, \psi^*)$ is the value of the likelihood function at the point $\psi^* = (\Theta^*, P^*)$ along with the prior and posterior ordinates at the same point. These quantities are rapidly obtained from the Markov chain Monte Carlo (MCMC) approach. The choice of the point ψ^* is in theory completely irrelevant but in practice it is best to choose high posterior density point such as the maximum likelihood estimate(Chip ,1998).

1. Markov chain Monte Carlo scheme (MCMC)

Suppose to specify a prior density $\pi(\Theta, P)$ on the parameters and that data Y_n is available. In the Bayesian context, interest on the posterior density $\pi(\Theta, P | Y_n) \propto \pi(\Theta, P) f(Y_n | \Theta, P)$. Note that the notation π denote to prior and posterior density function of (Θ, P). This posterior density is most fruitfully summarized by Markov chain Monte Carlo methods after the parameter space is augmented to include the unobserved states $S_n = (s_1, s_2, ..., s_n)$ .In other word, the posterior density $\pi(S_n, \Theta, P | Y_n)$ is computed by a Monte Carlo sampling (i.e. Gibb sampling)

2. Likelihood function at $\psi^* = (\Theta^*, P^*)$

A simple method for computing the likelihood function is available from the proposed parameterization of the change- point model. It is based on the decomposition.

$$Inf(Y_n | \psi^*) = \sum_{t=1}^{n} In f(Y_n | Y_{t-1}, \psi^*) \tag{2.71}$$

where

$$f(y_t | Y_{t-1}, \psi^*) = \sum_{t=1}^{n} f(y_t | Y_{t-1}, \psi^*), s_t = k) p(s_t = k | Y_{t-1}, \psi^*) \tag{2.72}$$

Eq.(2.72)is the one-step ahead prediction density. The quantity $f(y_t | Y_{t-1}, \psi^*, s_t = k)$ is the conditional density of Y given the regime $s_t = k$ whereas $p(s_t = k | Y_{t-1}, \psi^*)$ is the mass function at the hand, the states are simulated from time n (setting $s_n = m+1$). The one step ahead density (and, consequently, the joint density of the data) is thus easily obtained. It should be noted that the likelihood function is required at the selected point

ψ^* for the computation of the marginal likelihood. It is not required for the MCMC simulation.

3. Estimation by simulation

A Monte Carlo version of the EM algorithm can be used to find the maximum likelihood estimate of the parameter ((Θ, P)). This estimate can be used as the ψ^* in the calculation of the marginal likelihood.

Note that the EM algorithm entails the following step : First, the computation of function

$$Q(\psi,\psi^{(i)} = \int_{S_n} \ln(f(Y_n, S_n \left|\psi)\right) p(S_n \left|Y_n, \psi^{(i)}\right) dS_n \qquad (2.72)$$

Which require integrating S_n out from the complete data joint density ($f(Y_n, S_n|\psi)$) with respect to the current distribution of S_n given Y_n and the current parameter estimate $\psi^{(i)}$. The second step is the maximization of this function to obtain the revised value $\psi^{(i+1)}$.

Due to the intractability of the integral above, the first step is implemented by simulation. Because the integration is with respect to the joint distribution

$$p(S_n \left|Y_n, \psi^{(i)}\right. \equiv p(s_1, s_2, ..., s_n \left|Y_n, \psi^{(i)}\right.) \qquad (2.73)$$

The Q function may be calculated as follows. Let $S_{n,j}(j \le N)$ the N draws of S_n from $p(S_n|Y_n, \psi^{(i)})$ and let

$$Q(\psi) = N^{-1}\sum_{j=1}^{N} \ln\left\{ f(Y_n, S_{n,j} \left|\psi\right.) \right\} = N^{-1}\sum_{j=1}^{N} \left\{ \ln f(Y_n \left|S_{n,j}, \Theta\right.) + \ln f(S_{n,j} \left|P\right.) \right\} \qquad (2.74)$$

The M step is implemented by maximizing the Q function over ψ. This two-step process is iterated until the values $\psi^{(i)}$ stabilize (N is usually set small at the start of the iterations and large as the maximize is approached). The quantity thus obtain is the (approximate) maximum-likelihood estimate.

Each of these steps is quiet easy. Estimating the Q function requires draws on S_n and these are obtained by MCMC approach. In the M-step the maximization is usually straight forward and separates conveniently into one involving Θ in the sampling model and one involving P in the jump process. The latter estimates are

$$\hat{p}_{ii} = \frac{\Sigma_{j=1}^{N} n_{ii,j}}{\Sigma_{j=1}^{N}(n_{ii,j}+1)}, \quad i = 1,\ldots m, \tag{2.75}$$

where $n_{ii,j}$ is equal to the number of transitions from state I to state I in the vector $S_{n,j}$.

4. Marginal likelihood

The estimate of the marginal likelihood is completed by computing the value of the posterior ordinate $\pi(\psi^* | Y_n)$ at ψ^* . By definition of the posterior density

$$\pi(\Theta^*, P^* | Y_n) = \pi(\Theta^* | Y_n)\, \pi(P^* | Y_n, \Theta^*) \tag{2.76}$$

where

$$\pi(\Theta^* | Y_n) = \int \pi(\Theta^* | Y_n, S_n)\, p(S_n | Y_n) dS_n \tag{2.77}$$

And

$$\pi(P^* | Y_n, \Theta^*) = \int \pi(P^* | S_n)\, p(S_n, | Y_n, \Theta^*) dS_n \tag{2.78}$$

Since $\pi(P^* | Y_n, \Theta^*, S_n) = \pi(P^* | S_n)$. The first of these ordinates may be estimated as

$$\hat{\pi}(\Theta^*, Y_n) = G^{-1} \sum_{g=1}^{G} \pi(\Theta^* | Y_n, S_{n,g}) \tag{2.79}$$

Using the G draws on S_n from the run of the MCMC algorithm. The value $\pi(\Theta^* | Y_n, S_{n,g})$ may be stored at the completion of each cycle of the simulation algorithm.

The calculation of the second ordinate in Eq. (2.78) requires an additional simulation $\{S_{n,j}\}_{j=1}^{G}$ of S_n from $p(S_n | Y_n, \Theta^*)$. These draws are readily obtained by appending a pair of additional calls to the simulation of S_n conditioned on (Y_n, Θ^*, P) and P conditioned on within each cycle of the MCMC algorithm. Because the ordinate $\pi(P^* | S_n)$ is a product of Beta densities from the first m rows of P, the estimate of the reduced conditional ordinate in Eq.(2.78) is

$$\begin{aligned}\pi(P^* | Y_n, \Theta^*) &= G^{-1}\sum_{j=1}^{G}\prod_{i=1}^{m}\pi(p_{ii} | S_{n,j}) \\ &= G^{-1}\sum_{j=1}^{G}\prod_{i=1}^{m}\left\{\frac{\Gamma(a+b+n_{ii,j}+1)}{\Gamma(a+n_{ii,j})\Gamma(b+1)}\right\}p_{ii}^{(a+n_{ii,j}-1)}(1-p_{ii})^{(b+1=1)}\end{aligned} \qquad (2.80)$$

The log of the marginal likelihood $m(Y_n | M_i)$ is now given by

$$\begin{aligned}\ln \hat{m}(Y_n) &= \ln f(Y_n | \psi^*) + \ln \pi(\Theta^*) + \ln \pi(P^*) \\ &\quad - \ln \hat{\pi}(\hat{\Theta} | Y_n) - \ln \hat{\pi}(P^* | Y_n \Theta^*)\end{aligned} \qquad (2.81)$$

2.1.2.8 Forecasting

Forecasting is an under emphasized goal of many researchers because it is the most important and powerful tools of inference and policy analysis. To forecast the MS-BVAR model, there were the basic algorithm given by both Krolzig (1997) and Fruhwirth-Schnatter (2006) as follow:

Simulating the regime conditional on S_n sample the hidden Markov path recursively for S_{n+k} for $k = 1,....,s$. These are based on a BVAR(1) forecast of the Markov transition probabilities for $\Pr(S_{T+k} | s_{T+k-1})$

Simulating the forecasts conditional on the regimes drawn in the previous steps, use the parameters from the i^{th} draw of the posterior to construct a reduced form BVAR forecast for period T+k. Formally, consider an h-step forecast equation for the reduced form BVAR model:

$$y_{T+h} = cK_{h-1} + \sum_{l=1}^{P} y_{T+1-l} N_l(h) + \sum_{j=1}^{h} \in_{T+j} C_{h-j}, \quad h = 1, 2, ... \qquad (2.84)$$

where $\quad K_0 = I, \qquad K_t = I + \sum_{j=1}^{i} K_{i-j} B_j, \;\; i = 1, 2, ...;$

$$N_l(1) = B_l,\ \ l = 1, 2, ..., p;$$

$$N_l(h) = \sum_{j=1}^{h-1} N_l(h-j)B_j + B_{h+l-1},\quad l = 1, 2, ..., p, h = 2,$$

$$C_0 = A_0^{-1}, C_l = \sum_{j=1}^{i} C_{i-j}B_j,\quad i = 1, 2, ...,$$

whereas the convention $B_j = 0$ for $j > p, c(\ell)$ are the impulse response matrices for lag ℓ, K_i describing the evolution of the constants in the forecasts, and $N_\ell(h)$ define the autoregressive coefficients over the forecast horizon. This h-step forecast Eq.(2.74) gives the dynamic forecasts produced by model with structural innovation. It shows how these forecasts can be decomposed into the components with and without shocks. The first two terms in this equation are the sum of the effects of the past lagged values of this series and the constant or trends. The final term is the impulse response that determines the relationships among the variable innovations that affect the series. The C_i matrices are the impulse response for the forecasts at periods $i = 0, ..., h$ where the impulse at time 0 is the contemporaneous decomposition of the forecast innovations.

The key point in conditional forecasting is that setting the path of one variable, say y_{1t} constrains the possible innovations in the forecast of $y_{2t}....y_{mt}$. To see this, consider the following formulation for a hard condition on VAR forecast. Suppose that the value of

the $j^{'}th$ variable forecast is constraint to be $y(j)^{*}_{T+h}$. Then from Eq.(2.82) it follows that

$$y(j)^{*}_{T+h} - cK(j)_{h-1} - \sum_{l=1}^{p} y_{T+1} N_l(h)(j) = \sum_{j=1}^{h} \in_{T+j} C_{h-j} \qquad (2.83)$$

where the notation (j) refers to the $j^{'}th$ column matrix.

The left hand side of Eq.(2.83) implies that the innovations on the right hand side are constrained. That is, there is a restricted parameter space of innovations that are consistent with the hypothesized conditional forecast. These constraints can be express as a set of encompassing conditions. These hard conditions take the form of linear constraints:

$$\underset{q\times 1}{r(a)} = \underset{q\times k}{R(a)}' \underset{k\times 1}{\in}, \;\; q < k = mh \tag{2.84}$$

where $R(a)$ are the stacked impulse responses, the C matrices Eq.(2.83), for the constrained innovations and $r(a)$ are the actual constrained innovations(the left hand side of Eq.(2.83).The elements of these matrices correspond to the forecast constraints. The notation assumes that there are q constraints, and there can be no more constraints than the number of future forecast for all the variable, $k = mh$. In any case, the elements of R and r may depend on estimated parameter of the reduced form, denoted by a (the vectorized coefficients in stacking of the system matrices in compact from the VAR coefficient equation).

Finally, uses Gibbs sampling technique to generate the distribution of the conditional forecast. It could account for the path of the conditional shocks, and the possible uncertainty surrounding the parameters used to generate the respective conditional forecast (Brandt and Freeman, 2005).

2.1.2.9 Error Bands for Impulse Responses

Innovations accounting consists of computing the responses of the variables $y_{it} = y_i(t)$ for a specified shock of ε_j to variable j. These responses are typically found by Inverting the VAR model to moving average representation.

$$c_{ij}(s) = \frac{\partial y_i(t+s)}{\partial \varepsilon_i(t)} j \tag{2.85}$$

where $c_{ij}(s)$ is the response of variable i to a shock in variable j at time s.

Sims and Zha (1999) estimate the variability of the impulse responses by accounting for the likely serial correlation in the responses. Consider the responses for a single variable i with respect to a shock in variable j over H periods. Denote this vector by the sequence $\{c_{ij}(t)\}_{t=0}^{H}$. A sample of these sequences of responses can be generated using standard methods by sampling from the posterior density of the VAR coefficients and computing the responses. For these H responses, we can compute an $H \times H$ covariance matrix Σ that summarizes the variance of the responses of variable i to shock j with respect to time. This is done separately for each of the m^2 impulse response, that is for $i = 1,....m$ and $j = 1,...,m$. The benefit of using the m^2 covariance matrices Σ for computing the variance of the impulses is that they capture the serial correlation of the responses. The variation of the responses can then be analyzed using the following eigenvector decomposition:

$$\Sigma = W^{'}\Lambda W \tag{2.86}$$

$$\Lambda = diag(\lambda_1,....\lambda_H) \tag{2.87}$$

$$WW^{'} = I \tag{2.88}$$

The H -dimensional c_{ij} vector can be written as

$$c_{ij} = \hat{c}_{ij} + \sum_{k=1}^{H} \gamma_k W_k \tag{2.89}$$

where $\hat{c}_{ij}$ are the mean c_{ij} vector for each of the H periods, γ_k are the coefficients for the stochastic component of each response and W_k is the $k^{'}th$ eigenvector of W. The variation around each response is generated by the randomness of the λ coefficients. The variances of γ are the eigenvalues of the decomposition. The decomposition of the responses in Eq.(2.89) describes the responses in terms of the principal components of their variance over the response horizon as linear combinations of the main components of this variance.

The main variation in the impulse responses can be summarized using this decomposition by constructing the interval

$$\hat{c}_{ij} + z_a W_k \sqrt{\lambda_k} \tag{2.90}$$

where $\hat{c}_{ij}$ is the mean response of variable i to a shock in variable j, z_α are the normal pdf. quantiles, W_k is the k^{th} eigenvector decomposition of Ω and λ is the eigenvalue of the k^{th} eigenvector. This Gaussian linear eigenvector decomposition of the error bands characterizes the uncertainty of the response of variable i to shock variable j in terms of the principal sources of variation over the response horizon. If the k^{th} eigenvalue explains $100 \cdot \frac{\lambda_k}{\sum_{t=1}^{H} \lambda_i}$ percent of variance, then this band will characterize that component. Not that this method assumes that the responses are joint normal over the H periods. Further, these bands still assumes that the responses are joint normal over the H periods. Further, these bands still assume symmetry.

Brandt and Freeman (2005) look at the quantiles of this decomposition. This may be preferred because the assumption that the error bands are joint normal will likely not hold as the impulse response horizon increases. To compute these likelihood-based (or Bayesian) error bands using the Mont Carlo sampler of c_{ij} and compute the quintiles of the γ_k, which summarize the main variation in the c_{ij}. This is done as follows:

1. Computing Σ for each impulse

2. Computing $\gamma_k = W_k c_{ij}$, where W_k are computed from eigen- vector decomposition

3. Estimating γ_k from each of the responses in the Monte Carlo sample of responses. The quintiles of the γ_k across the Monte Carlo sample can be used to constructed error bands. Typical quintiles will be one and two standard deviation error bands (16-84%, and 2.5-97.5%). The using the general rows of W_k that correspond to the largest eigenvalues of Σ. The bands constructed in this manner will account for the temporal correlation of the impulses:

$$\widehat{c}_{ij} + \gamma_{k,0.16}, \ \widehat{c}_{ij} + \gamma_{k,0.84} \qquad (2.91)$$

As such, these bands assume neither symmetry nor normality in the impulse response density. Their location, shape, and skewness are more accurate than bands produced by other methods because they can account for the asymmetry of the bands over the time horizon of the responses (Sims and Zha ,1999 as cited in Brandt and Freeman, 2005).

The Conclusion of Notion and Theoretical of Econometric

A notion and theoretical of econometric begin with unit root test, augmented dickey fuller test, in order to test the stationary or non-stationary of the data. In this study, I employ a reduced VAR as an initial estimation model. Then the lag length criteria has been tested in order to determine the autoregressive lag length with good fit to the data using AIC and SIC. It, however, still has the problem of over-parameterizaton. I extend VAR model to Bayesian vector autoregressions (BVAR) which has been found to give better results and has a good forecasting (Maddala, 2001). To estimate the BVAR model, using Markov Chain Monte Carlo (MCMC) via Gibbs Sampling. Then, I extend the B-VAR to Markov Switching Bayesian Vector autoregressive (MS-BVAR) model in order to capture the regime switching in the time series data. However, there were many types of model in MS-BVAR which depend on the prior distribution, the number of regimes and restriction in variance and covariance, so Chib (1998) had proposed comparison of the model by marginal likelihood in order to choose the best fit to the data. Moreover, the propose of this study is date the effect QE as well as identify a factor that impacted to TIP markets and signal ahead a turbulent regimes as early warning systems. Therefore, the impulse responses and forecasting also have been estimated.

2.2 Literature Review

2.2.1 Method review

The sensitive of domestic and international financial markets, in particularly emerging markets, to the effect of unconventional monetary policy or QE, has been investigated by many researches. These researches had been done using different methods, different countries under different contexts. For instance, Cho and Rhee (2013) studied the effect of United States (US) QE on Asia using regression analysis while Fernandes (2012) studied the effect of US's QE on domestic financial markets using also regression analysis; Bowman, Cai, Davies and Kamin (2011) studied the effect of Japan's QE on domestic financial markets and also using regression as well ; Joyce ,Lasaosa, Stevens and Tong (2010), Breedon, Chadha and Waters (2011) investigated the impact of United Kingdom QE on domestic financial markets using vector autoregressive (VAR) and multivariate generalized autoregressive conditional heteroscedasticity (GARCH) and structural vector autoregressive (SVAR), respectively; Chen, Filardo, He and Zhu (2011), Fratzscher, Duca and Straub (2013) studied the effect of US QE on emerging markets economies.

Many studies have employed the linear model in order to capture the effect of QE. However, it has not corresponded to real economy with regime shifts. Thus in this study, I aim to employ the non-linear model which more appropriate to financial time series in order to capture discrete changes in the financial time series data.

In time series econometrics approach has been rapidly developed along last decade, in particularly the treatment of regime shifts and non-linear modeling strategies. Since economic and financial systems are known to go through both structural and behavioral changes, it reasonable to assume that there are regime shifts in macro-econometric system (Zivot and Wang, 2006). A time varying process posed problems in estimating and forecasting when a shift in parameter occurs. The degradation of performance of structural macroeconomics models seem at least partly due to regime shifts, increasingly, regime shifts are not considered as singular deterministic events, but the unobservable regime is assumed to be governed by an exogenous stochastic process (Krolzig, 1997). Thus, many models have been developed on the statistical analysis of multiple time series with regimes shift in order to estimate and forecast the macro-economic systems accurately.

Substantial model has been conducted on the estimation of macro-economic systems time series with non-linear model such as the state dependent model of Priestley (1980); threshold autoregressive (TAR) models, which is probably first proposed by Tong (1978) and discussed in detail in Tong (1990); Smooth transition autoregressive (STAR) ,generalized from TAR models, is proposed by Granger and Teravirta (1993) : SETAR , which introduced by Howell Tong in 1977 and more fully developed in the seminal paper (Tong and Lim, 1980); nonparametric and semi-parametric methods such as kernel regression and artificial neural network (ANN), Markov switching autoregressive (MS-AR) , which contributed by Hamilton (1988,1989) and Klozig (1997) applied the MS –AR and introduced Markov switching vector autoregressive (MS-VAR) which captures the co-movement of many endogenous variables. The selection of the model may depend on the experience of the analyst and the substantive matter of the problem under study (tsay, 2005)

However, TAR and STAR model seem to have some restriction. Kuan (2002) suggested that these models are too complicated and non-flexible, nevertheless, ANN model seem to deal with these problem because it has diversified and comprehensive estimation. But it still has an identification problem which may risky to be an application in non-linear time series model. Therefore, Franses and Dijk (2000) suggested, the famous model which has widely conducted, a regime switching model. (as cited in Thakolprajak, 2012). Ismail and Isa (2006) considered SETAR and MS-VAR where these model can explain the abrupt changes in a time series. They found that MS-VAR is the best fitted model for all the return time series data. However, MS-VAR may face the degree of freedom problem, have a large number of coefficients which have no explanatory power, and there strong convergence problem and can cause forecasting problem (Anas, et.al., 2004). Payaslioglu (2008) confirmed that a Markov switching model would be particularly appropriate to capture the salient features of the data, and to produce accurate forecasts. However, it may face the over- parameterized problem.

According to above issue, MS-BVAR model, developed by Sims et al. (2008), is employed to this study in order to identify sudden behavioral change of financial variable including stock and bond market and exchange rate from the impact of QE programs because it could deal with the over- parameterized problem in MS-VAR. Brandt and Freeman (2006) suggested to use Bayesian prior on the coefficient matrix of the model to reduce the estimation uncertainty and obtain accurately inference and forecast.

MS-BVAR has been adopted by many studies, in various fields. Aboura and Roye (2013) examined the effect of financial stress on the economic dynamic in France; Nason and Tallman (2012) investigated the effect of financial sector shock on the EU activities. Hartman, Hubrich, Kremer and Tetlow (2012) studied the effects of systematic stress on economic performance in euro area; Amisano and Colarecchino (2013) examine the relationship money growth and inflation in advance countries; and Lhuissier (2013) stidied the effects of shoch in financial sector on economics activity of Euro area.

2.2.2 Variable review

This section describes the variable which the MS-BVAR model are estimated. I divide a variable into 2 groups. First one is the Quantitative Easing variable including value of US's treasury securities (TS_t), Mortgage-backed securities: Maturing in over 10 years(

MBS_t), and Federal's balance sheet(FB_t), and the second group is the impacted financial variable including Stock exchange of Thailand index(SET_t), Jakarta Composite Index (JKSE_t), Philippine Stock Exchange composite index (PSEi_t), THB/USD (EXth_t), IDR/USE (EXind_t), PHP/USD(EXph_t), Thai government bond yield (THY_t), Indonesia government bond yield (INDY_t) and Philippines government bond yield (PHY_t). Moreover, there are 3 information sets (Y_t) of this study consist with as follow,

TIP stock markets information set $Y_{\mathrm{stock,t}} = (FB_t, MBS_t, TS_t, SET_t, IDX_t, PHEi_t)$

TIP exchange markets information set $Y_{\mathrm{ex,t}} = (TS_t, MBS_t, FB_t, EXth_t, EXind_t, EXph_t)$

TIP bond markets information set $Y_{\mathrm{bond,t}} = (TS_t, MBS_t, FB_t, THY_t, INDY_t, PHY_t)$

2.2.3 Quantitative Easing variable

Studying the QE effects, there distinguished between 2 types of unconventional monetary policy measures in the analysis. First, an announcements date which treat as a dummy variable. There were many studies which used the announcements date as QE variable such as Joyce ,Lasaosa, Stevens and Tong (2010), who studied the financial markets impact of QE in England; Krishnamurthy and Jorgensen (2011), who studied the effect of US QE on interest rate while Christensen and Gillan (2013), who examined on market liquidity in US, Cho and Rhee (2013), on emerging market. The second set of policy measures related to actual operations of QE. the term spreads between 10-year and 3-month government bond yields are used as QE variable for the US by Chen, Filrado, He and Zhu (2011) opposite to Chen et al (2011), who used long term debt as variable. While Breedon, Chadha and Waters (2011) used the bank of England's monetary policy interest rate, debt-to-GDP ratio and ration of long term bonds to nominal debt outstanding. Bowman, Cai, Davies, and Kamin (2011) used the ratio of liquid assets to total bank assets to be a Japan QE variable. Moreover, Werner (2009) suggest that the true meaning of QE was Bank credit, trade credit, central bank credit, and government credit (as cited in D. Ledenyou and V. Lendenyov, 2013). However, Fratzscher, Duca and Straub (2013), used both 2 types of QE variable that is anoucments date as dummy variable and outstanding amounts of purchases of long term Treasury bonds and of purchases of long term mortgage backed securities and debt as quantity variable.

Nevertheless, Fratzscher, Duca and Straub (2013) found that the actual operation impacted even larger than Fed announcements. So, on this study, I measure the QE effect as weekly changes of outstanding amounts of purchases of long term Treasury bonds and of purchases of long term mortgage backed securities and debt.

2.2.4 Impacted financial variable

Quantitative Easing remains highly controversial of its effectiveness both in term of its domestic and international countries especially in emerging market economy. There were many studies which worked on the impacted of QE as a unconventional policy on EMEs. There were many variable which has been conducted as a proxy of the additional impact on EMEs such as capital inflows in bond fund, capital inflow in equities fund, equities index return, change in bond yield and exchange rate, which were used by Fratzscher, Duca and Straub (2013). Chen, Filardo, He and Zhu (2011) used money growth, Gross Domestic Products (GDP), consumer price index(CPI), equities index, foreign exchange pressure and bank credit. Cho and Rhee (2013) used Index of global investor sentiment and market volatility and oil price. Zhu (2013) used consumer price index of china, imported good price index of china and foreign exchange reserves value of china and Chua, Endut, Khari and Sim (2013) conducted GDP, CPI ,oil price, stock index, exchange market pressure(calculated as cited in per Eichengreen, Rose, Wyplosz, 1994), bank credit to investeror, house price as impated financial variable. However, there are some variables that that have large effect on EMEs. and Chua, Endut, Khari and Sim (2013) suggested that QE generated non-trivail spillover effects on asset price, exchange market pressure and monetary condition in EMEs; but on the contrary, Morgan (2011), Chen; Filardo, He and Zhu (2012); and Cho and Rhee (2013) confirmed a significant impact of U.S. Quantitative Easing, which lowered emerging Asian bond yields, boosted stock prices and exerted upward pressures on exchange rates against the dollar. In this study, thus, I use stock index, exchange, bond yields (represented by local currency total return index) as an impacted financial variable.

On the other hand, these variables are in no way limited to QE studies, which exclusively focus on the QE effects. There were conducted by various studies, using a regime switching model.

1) Stock index

Stock index is a popular variable in modeling nonlinearities particularly regime switching model. For instance, Ismail and Isa (2008) investigated the relationship among the return of stock markets from Southeast Asian counties using a stock index as variable; Ismail and Rahman (2009) examined the relationships between US and selected Asian Stock markets ; Aranda and Jaramillio (2008) investigated the possible presence of nonlinear dynamics for stock index return and trading volume at the Chilean Stock market while Balcilar and Ozdemir (2013) analyzed the causal link between oil future price and S&P 500 index change.

2) Bond yield

According to Migiakis and Bekiris (2007) used UK government bond yields to examined the cointegration relations with equity yields. As well as, Hevia, Rozada, Sola and Spagnolo (2012), who estimated and forecasted the US government bond yield; Pozzi and Sadaba (2012), who examined the impact of the global financial crisis on government bond risk pricing while Leschinski (2012) applied a Markov switching mixture copula model to study contagion effects between bond yields of Greece and other affected countries during the European sovereign debt crisis.

3) Exchange rates

This variable will be modeled using MS-VAR model as suggested by Payaslioglu (2008) who examined the transmission of shocks among East Asian currencies; by Vargas III (2009) who used this variable to develop the early warning system of currencies crisis ; by Mostafaei and Safaei (2013) who forecasted U.S. Dollar/Euro Exchange rate. In addition, Goutte and Zou (2011) have clearly documented that regime switching model fits much better foreign exchange rate than non-regime switching model.

4.3 Literature review about Quantitative Easing

Bognanni (2013) investigated the Quantitative effects of fiscal and monetary policy instruments in order to answer the following questions: 1) how much does government spending stimulate GDP? 2) how nominal rigid are prices and do these rigidities differ across of the economy. For this propose, He used state of the art macro-econometric techniques to answer these question. Firstly, he employed the Markov switching vector autoregressive (MS-VAR) framework to estimate the model with multiple regime-switching processes and used MS-VAR prior that centers lagged coefficients in the VAR at different values for different states. Secondly, using the extension of MS-VAR framework, estimated 8 variables structural VAR with Markov-switching in selected parameters to investigate which the fiscal multiplier varies over time and what factor cause the time variation. Lastly, he estimated a Dynamic Stochastic General Equilibrium (DSGE) model with firm input –output relationships and sectoral heterogeneity using both Bayesian and General Method of Moments (GMM)

Throughout the dissertation he worked within Bayesian paradigm of statically inference for making inference in small sample setting. In this dissertation, he estimated model using 7 data series from first quarter of 1964 to the last quarter of 2009. These included wages in each sector, inflation in each sector, real per capita money, real per capita consumption, and real per capita investment.

The results of the MS-VAR estimation suggested that “expansionary” fiscal policy may not expand GDP at the economy most badly needs an expansionary policy intervention.

The result of 8 variables structural VAR with Markov-switching in selected parameters estimation gave the following results 1) without imposing the reason for variation a priori, the business cycle is the most likely source of time variation in fiscal multiplier. 2) The fiscal multiplier is likely smaller in recessions than expansions. 3) Inference about fiscal multipliers that vary over the business cycle depends crucially on the choice of observations that inform the parameters for each state of the world.

The result of DSGE estimation found that DSGE models may suffer from misspecification along dimension important for evaluating the fiscal effect. With regards to assessing nominal rigidities, he found that the choice of estimation method is a key in evaluating the extent of nominal rigidities in multi-sector DSGE models. Likelihood – based estimation methods estimated lower values of nominal rigidities than do moment based approach

Fratzscher, Duca and Straub (2013) analyzed the global spillovers of the Federal Reserve's (FED) unconventional monetary policy (QE) effect on the United States (US) and on 65 foreign financial markets. They emphasized the actual Fed operation (QE action) on asset price and portfolio decisions rather than focused on QE announcements. For this propose, they used a daily data of portfolio flows into bond and equity markets of US and other 65 countries which included emerging market economy(EME) and advanced economy (AEs) countries. They collected a daily data from January 2007 to December 2010.

They analyzed different action of QE in order to understand whether and why QE1 and QE2 have different effect to US and foreign markets. They analyze the response of portfolio decisions, asset and exchange rates to specify QE actions and events. Importantly, they differentiate between US and foreign variables in order to test whether foreign markets were affected differently from each QE program. So, they evaluated the impact of QE using the following model:

$$P\left(Crisis_t \,|\vartheta_{t-1}\right) = P(S_t = 1|\vartheta_{t-1})$$

whereas

$y_{i,t}$ = Net inflows into bonds or equities, expressed in percent of all assets under management, equity price returns, the first difference of long term bond yields or the exchange rate return in country i and day t.

D_i^{EME} = Dummy of country i in an emerging market economy; $0 < D_i^{EME} < 1$

D_i^{AE} = Dummy of country i in an advanced economy; $0 < D_i^{AE} < 1$

β = Impact of the a particular policy measure on US

γ = Impact of the particular policy measure on EMEs and AEs

They distinguished between 2 types of QE in the analysis. QE1 and QE2 denoted as AN1 and AN2, respectively.

A first key result of this empirical analysis found that QE1 policies were highly effective in lowering sovereign yields and raising equity markets, especially in the US relative to other countries. QE2 boosted equities worldwide, while it had muted impact on yield across countries. Thus, Fed policies function in a procyclical manner for capital flows to EME countries and counter- cyclical for the US, triggering a portfolio rebalancing across countries out of EME countries to US equity and bond markets under QE1 and in opposite direction under QE2. Second, the impact of QE, such as Treasury and Mortgage backed securities (MBS) purchases, exerted substantial larger effect on portfolio decision and assets price, than Fed announcements of these programs. Third, they found no evidence that limiting exchange rates or imposing controls on capital account openness helped countries shield themselves from the impact of QE. However, they suggested that the impact of QE policies is partly linked to pull factors in recent countries and specifically to risk and flight to safety phenomenon.

Guo, Hu and Jiang (2013) studied the effect of monetary shocks on the Chinese stock market over the period of 2005 to 2011 with Markov switching vector autoregressive – exponential generalized autoregressive conditional heteroscedasticity (MSVAR-EGARCH). They collected data on the rate of return of the shanghai Composite Index ($\Delta Index_t$), the percentage change of RBM Interest Rate (Δr), Exchange Rate(Δr_{et}), Required Reserved Rate(Δ_{dt}) and Money Supply (M2) (ΔM_t). Their sample was monthly data which covered the period from June 2005 to December 2011.

They adopt the MSVAR-EGARCH in order to explore the impact of the monetary shock in different market cycles. The MS(p)-VAR(q) model is specified as follows:

$$Y_t = \mu s_t + \sum_{k=1}^{q} As_t \times Y_{t-k} + \varepsilon_t$$

Where Y_t = Vector of $\Delta Index_t\ \Delta r_t\ \Delta r_{et}\ \Delta_{dt}\ and \Delta M_t$

ε_t	=	Random error
s_t	=	The unknown state variable following a p-state Markov process with the transition probability
μs_t	=	Constant vector
As_t	=	coefficient matrix

In order to study the asymmetric effects of current positive/negative monetary shocks, they chose the EGARCH model (Nelson, 1991), which reasonably deals with the non-normal distribution of the conditional heteroskedasticity brought by disturbance term. The model is specified below as

$$\varepsilon_t = A_l \times \Omega_t + e_t$$

The evidence suggested that Chinese monetary policies have significantly asymmetric effects on the stock market in different time periods and market cycles. The effects of shocks from interest rate and reserve rate vary across market cycles but effects from money supply and exchange rate do not vary across market cycles. Empirical evidence from the non-linear model showed that monetary policy changes increase stock market volatility, even though these monetary policies are often aimed at stabilizing macroeconomic activities. The evidence also suggested that both the market conditions and the effects on stock markets should be taken into consideration in monetary policy design and implementation.

Bowman, Cai, Davies and Kamin (2011) studied the effect of Japan's Quantitative Easing policy or QEP on macroeconomic performance in particularly bank lending. They used a novel approach to evaluate the effect of QEP on bank lending using data on individual banks. They collected bank level data from September 2000 to March 2009 and are taken in form semi-annual balance sheet reports. Using panel data for 138 banks over the nine years period, they study the relationship between the growth and the liquidity ratio, which defined as the ration of liquid assets to total bank asset, their baseline regression is:

$$\Delta Loan_{i,t} = \alpha + \beta LR_{i,t-1} + \delta' X_{i,t-1} + \varepsilon_{i,t}$$

whereas

$Loan_{i,t}$	=	Natural log of loans made by bank I at time t
$LR_{i,t-1}$	=	Liquidity ratio for bank I at time t
$X_{i,t-1}$	=	Vector of control variables for bank I at time t

The control variables included bank size, measured by total asset; the equity ratio, measure by net assets as a percentage of total assets; the bad loan ration, measure as the ration of notional value of non-performing loans, as define by the Japanese Banking Law, to net asset; lags of deposit growth, and lags of loan growth. They also included semi-annual time dummies as well as dummy variables for varying bank types. They estimated the baseline model using GMM procedure implemented as instrumental variables. The used this technique in order to control for endogeneity problems in panel data with small T and large N, as well as endogenous and predetermined regressors. They also tested whether various bank characteristics affected the sensitivity of bank credit supply to central bank liquidity provision during the QEP period. They added interaction terms between the liquidity ratio and total bank assets, equity ratio and bad loan ratio, respectively. The specification is follow:

$$\Delta Loan_{i,t} = \alpha + \beta LR_{i,t-1} + \delta' X_{i,t-1} \gamma' (LR_{i,t-1} \cdot X_{i,t-1}) + \varepsilon_{i,t}$$

As the result, they found that QEP has a little positive impact to bank lending because it has been substituted by central bank liquidity for interbank liquidity. They also found that weak banks benefited more from QEP than stronger banks.

Breedon, Chadha and Waters (2011) focused on the impact of the United Kingdom(UK)'s initial 2009-2010 Quantitative Easing (QE) Program on bond and other assets. They aimed to bypass most of these problems through 2 empirical approaches. First they estimated a macro finance model of UK government liability curve which allows them to construct a counterfactual estimate of their structure over the QE period to stimulate the impact of QE on the yield curve directly. A macro finance term structure model is estimated in 2 stages. The first stage involved putting the term structure into the functional form proposed by Svensson (1994). The second step is to relate these latent factors to a representative set of macroeconomic variables through a

SUR regression. They collected the data included maturities of 9, 12, 15 ,18, 21, 24, 30, 36, 48, 60, 72, 84, 96, 108 and months for zero coupon forward curve at monthly frequency between March 1993 to December 2008. The macroeconomic variables are divided into 5 groups that is inflation (inflation expectations), real activity (real activity index and unemployment rate), policy (Bank of England monetary interest rate, debt to GDP ratio, ratio of long term bonds to nominal debt outstanding. Foreign (exchange rate, German retail sales, the IFO index of business climate, US Non-Farm Payrolls and Fed Fund Rate) and financial(index of annual returns of three different equities series, and Libor spread).

Second, they looked in a detail at the liquidity effects of the QE operation and assessed these liquidity effects beyond the gilt market. They used daily data in bond price in order to compare with other asset such as equities and the exchange rate. They focused on bonds eligible for the relevant operation. They looked at price movements relative to 2 benchmarks. First, a simple “no change” scenario, so that the significance of price movements around QE operations is judged against the hypothesis that prices should on average be unchanged across the whole event window. Second, they constructed a counterfactual daily path for bond prices based on a linearly interpolated prediction from the yield curve model. The effectively helped control for any trend in prices over the event window that is due to underlying macroeconomic developments.

The result of this study found that QE significantly lowered government bond yields through the portfolio balance channel by around 50 to 100 basis points, They also uncovered significant effects of individual operations but limit pass through to other assets

Chen, Filardo, He and Zhu (2011) studied the cross border impact of Quantitative Easing (QE) in the major advanced economies, especially on emerging market economies in Asia and Latin America. They analyzed the effect of Federal Reserve balance sheet policies on real activity in other economies and understand both domestic and international transmission of QE policy. They contributed the study in 2 ways, first, they use event study techniques to examined the cross-border financial market impact of such policies, and second, they studied the real effects of Quantitative Easing using global Vector Autoregressive model (GVECM) which developed by Pesaran, Schuermann and Weiner (2004). It provides a multilateral dynamic framework for the analysis of interdependence and international transmission of country- specific shock among large number of economies. The monthly data were collected from February 1995 to December 2010, on 17 economies. These include 4 advanced economies: the United States, Euro area, Japan and the United kingdom; nine emerging economies in Asia: China, Hong Kong SAR, India, Indonesia, Korea Malaysia, the Philippines, Singapore and Thailand and Thailand; and four economies in Latin America: Argentina, Chile, Brazil and Mexico. The set of endogenous variable are real GDP, bank credit and equity prices, an indicator of monetary policy, foreign exchange index and Inflation rate. The set of exogenous variable are foreign real GDP, Inflation rate. Oil price is included for each economy but with different specifications to account for different country dynamics.

The result of event studies found that US Quantitative Easing sizeable expansionary impact on emerging financial markets. It influenced prices of emerging market assets, raising equity prices, lowering government and corporate bond yields and compressing CDS spreads. The evidence also support that QE programs in advance economies influenced market expectation about strength of cross border financial flows to emerging market economies.

According to GVECM result, suggested that US Quantitative Easing has impact on emerging economies in the short run and medium term. The size of the estimated international spillover effects differs across regions. First, lower U.S. treasury bond yields raise equity prices significantly in advanced economies, but the expansionary impact on growth and inflation was only about half of that on U.S. economy. Second, there was little evidence that lower yields in the U.S. led to rapidly increase credit in other advanced countries. Third, the impact on emerging economies was stronger than other advanced economies. In some economies such as Hong Kong and Brazil, QE was significant affected to credit growth and capital inflow, currency appreciated and inflation pressure. In the result of domestic transmission of the U.S. Quantitative Easing, found that the most significant impact was probably on U.S. stock prices.

Minghua,Yixiang, Chenggang and Cong (2011) aim to tested the dual asymmetric effect of monetary policy shock in stock and bond markets in China. This paper selected monthly time series data from January, 2000 to December,2010, including the return of Shanghai Composite Index (RS) and S&P CITIC Bond Index

$$D_{jt} = \begin{cases} 1 \; if \;\; market \; j \;\; in \; fall \; period \\ 0 \;\; if \;\; market \; j \, in \, rise \; period \end{cases}$$

The test results show that the expansionary and tight monetary policy shocks on the stock and bond markets have dual asymmetric effects both rise and fall periods.

Joyce ,Lasaosa, Stevens and Tong (2010) studied the financial impact of Quantitative Easing(QE) in United Kingdom financial markets. They evaluated the impact of Bank's program of large-scale asset purchase or Quantitative Easing (QE) which resulted in the Monetary Policy Committee (MPC) making 200 billion pound sterling of purchase in UK government securities (gilts). They also aim to quantify how QE has directly effected on gilt markets and other financial asset price i.e. corporate bond yield, equity prices and option prices. The data consist of end of month realized returns and asset shares of 4 different asset that is equities (FTSE All Share), corporate bonds (total return and market value), nominal gilts (total return and market value) and broad money (M4) from December 1990 to February 2010. They used several approaches in order to isolate the impact of QE. First, they examine the reaction of the financial market around each announcement of QE. They found that the gilt yields had been decreased 100 basis points after an announcement of QE. The main cause of this effect came from the portfolio rebalance channel. In the other financial effect, they found that the corporate bond yield, probably the substituted for gilts, significantly fell after announcement of QE in a few months later. Equity prices fell immediately fall after the initial announcement of QE and the balance of risks perceived by market participants around equity prices implied by option become less negative. They also found that there were substantial increase in liquidity in equity and corporate bond markets. Second, they tried to examine the QE by using historical experience. They stimulated QE's impact using 2 econometric models, a basic vector autoregressive (VAR) model and Multivariate generalized autoregressive conditional heteroscedasticity (GARCH) in mean model, based on portfolio balance framework. In VAR model, they estimated a VAR which includes both excess return and asset shares and also allow the influence of a set of exogenous variables in order to capture other influence on asset demand and supply. The goodness of this model is that it allow asset supplier to be treated as endogenous and to respond to movement in excess return. However, because of the assumption of VAR model, assumes that the covariance matrix between asset returns is constant, they employed the multivariate GARCH in mean model which relaxes the assumption of VAR model. This approach allowed them to estimate a time varying-covariance structure, but treat asset share as exogenous. The result of these 2 model suggested an impact through the portfolio balance channel on gilts and corporate bonds is similar to the observed using analysis of announcement reactions. However it also suggested considerable uncertainty about size of the impact, in particularly the impact of equity returns. Moreover, VAR analysis would not have predicted the large pickup in issuance that occurred in 2009

Vargas III (2009) aim to develop an early warning system (EWS) on currency crises for 4 Asian Financial Crisis countries: Indonesia, Malaysia, Philippines and Thailand by identifying factors that can serve as leading indicator of vulnerability of an economy from speculative attacks. The components of the index of speculative pressure(ISP) are modeled using Markov switching vector autoregressive (MSVAR) with time varying transition probabilities (TVTP) with adapted from Martinez Peria's (2002) model. The data consist of month on month percentage change in the nominal exchange rate, and the foreign exchange reserve and interest rate between a country and the United States (U.S.).The monthly data were collected from 1980 to 1999. Moreover, real Overvaluation, trade balance, FX reserve adequacy, credit overexpansion, real economy, short-term capital flow, capital flow reversal, center bank bailout and bank confidence are collected

MSVAR with TVTP was used in order to avoid the problems associated with other

econometric models and identified of significant factors that influence the probability of an economy going into a turbulent period and expected value of the index of speculative pressure. In this study, a logistic functional form of the TVTP is specified and shown below.

$$S_t = \begin{cases} 1, turbulent \\ 2, ordinary \end{cases}$$

$$p_t^{11} = P(S_t = 1 \middle| S_{t-1} = 1, x_{t-1}; \zeta^1) = \frac{\exp(x_{t-1}\zeta(S_{t-1} = 1))}{1 + \exp(x_{t-1}\zeta(S_{t-1} = 1))}$$

$$p_t^{12} = 1 - p_t^{11}$$

$$p_t^{22} = P(S_t = 2 \mid S_{t-1} = 2, x_{t-1}; \zeta^2) = \frac{\exp(x_{t-1}\zeta(S_{t-1} = 2))}{1 + \exp(x_{t-1}\zeta(S_{t-1} = 2))}$$

$$p_t^{21} = 1 - p_t^{22}$$

The equations of the transition probabilities above indicate that the transition probabilities are one period forecast. The mean equation that is specified by an MSVAR model express as follow:

$$y_t \quad = \quad \alpha_0(S_t) + \alpha(S_t)y_{t-1} + \sigma(S_t)\eta_t, \text{where}\, \eta_t \sim N(0, I)$$

y_t = vector of endogenous variables consisting of the change in nominal exchange rate, foreign reserve, and interest rate

S_t = regime (1=turbulent, 2=ordinary)

η_t = Matrix of error term

Therefore, they can write the Index of speculative pressure (ISP) from MSVAR with TVTP as follow:

$$ISP_t(S_t) = \quad \Delta ER_t(s_t) + \frac{\sigma_{\Delta ER}(S_t)}{\sigma_{\Delta ER}(S_t)}\Delta FR_t(S_t) - \frac{\sigma_{\Delta ER}(S_t)}{\sigma_{\Delta ID}(S_t)}\Delta ID_t(S_t)$$

from which the expected ISP is derived and given by

$$ISP_t = \quad P(S_t = 1 \mid \vartheta_{t-1}) ISP_t(S_t = 1) + P(S_t = 2 \mid \vartheta_{t-1}) ISP_t(S_t = 2)$$

where

$$P(S_t = 1 \mid \vartheta_{t-1}) ISP_t(S_t = 1) = P_t^{11} + P_t^{21}$$

And

$$P(S_t = 2 \mid \vartheta_{t-1}) ISP_t(S_t = 2) = P_t^{22} + P_t^{12}$$

The P_t^{11}, P_t^{12}, P_t^{22} and P_t^{21} are the transition probabilities and conditional information up to t-1, that is, ϑ_{t-1}

There were 2 ways of defining a crisis probability. The first one is the probability of turbulent regime $P\left(S_t = 1\right)$, that is,

$$P\left(Crisis_t \left| \vartheta_{t-1}\right.\right) = P\left(S_t = 1 \left| \vartheta_{t-1}\right.\right)$$

and second one is

$$P\left(Crisis_t \left| \vartheta_{t-1}\right.\right) = P\left(ISP_t < \tau \left| \vartheta_{t-1}\right.\right)$$

This study showed that MSVAR with TVTP is good method to use in building an early warning system of a currency crisis. Results show significant improvement on predicting the Asian Financial Crisis by signaling its occurrence at an earlier period with higher probability when the probability of a turbulent regime was employed. It confirmed a stylized fact that the turbulent regime has higher volatility than an ordinary regime in all four currencies. The leading indicators of the Asian Financial Crisis identified in this study are real effective exchange rate, export growth, GDP growth, real domestic credit, M2 ratio, deposits to M2 ration and non FDI flows.

Giradin and LIU (2005) examine the impact of global (New York) and regional (Hong Kong) financial market to china's stock market. They collected data at the weekly frequency (middle of the week), for the period from the third week of April 1993 through the third week of October 2004. They considered the logarithm of the Shanghai A-share index, of the Hang Seng Index, and of the Standard and Poor's 500(S&P, 500) as a representative of China stock market, of Hong Kong stock market and New York stock market , respectively. They first re-examined the issue of existence of long run relationship of active trading in the A-share market using cointegration test which developed by Johansen(1988,1991) . They considered the A-share index in dollar in order to account for point of view of an international portfolio diversification strategy. The result show that there were no long run relationship between the Shanghai A-share market index, the standard and poor's 500 and the Hang Seng index. So, they separated the period of time around late September 1997 (East Asian crisis) . They found that Shanghai is cointegrated with New York prior to the crisis, with a deterministic time trend, and with Hong Kong after the crisis, with no trend.

Second, they studied a dynamic relationship using a Markov switching Vector Error Correction model (MS-VECM) which suggested by Hamilton (1994) and extended to non-stationary system, in particular to vector error correction system by Krolzig (1997). Krolzig (1997) also showed that, if cointegration is present, it is possible to write the joint dynamics of the vector time series process as MS-VECM, as follow:

$$\Delta p_t = v(s_t) + \sum_{d=1}^{n-1} \Gamma_d (s_t) \Delta q_{t-d} + \chi(s_t) \Pi q_{t-1} + e_t$$

whereas $V(s_t) = [v_1(s_t), v_2(s_t), ... v_M(s_t)]$ a M-dimensional column vector of regime-dependent intercept term. Γ_d are the M×M Matrices of parameter, $\Pi = \alpha\beta$ is the M×r cointegrating matrix with r the number of cointegration, ε_t is a M-dimensional vector of error term , $\varepsilon_t \sim NIID(0, \Sigma_\varepsilon(s_t))$. They assumed that the regime –generating process is an ergodic Markov chain with finite number of states s_t

They also consider a Markov-switching Intercept- Autoregressive – Heteroscadastic VECM or MSIAH-VECM, in which speeds of adjustment to equilibrium can vary between regimes

$$\Delta p_t = v(s_t) + \Sigma \Gamma_d (s_t) \Delta p_{t-d} + D_t \Pi^1 (s_t) p_{t-1} + (1 - D_t) \Pi^2 (s_t) p_{t-1} + e_t$$

with D_t is dummy variable whereas $D_t = 1$ is first cointegrating relationship and $D_t = 0$ is second cointegrating relationship. They , thus, allowed β coefficient vary over time and the intercept $V(s_t)$ can switch between states. With Markov-swithching heteroscadasticity, the variance of error can differ between regimes. In this study, there were 2 regimes for MS-VECM : pre-crisis regime and post-crisis regime.

This approach led them to consider to what extent the significant of the error correction term is regime-dependent and assign probabilities of the occurrence of the different regime. The result show that prior to the East Asian crisis negative deviations from the long run relationship with New York led to substantial and significant error correction, while lagged of S&P 500 index had substantial impact on Shanghai index, while subsequently the only dynamic effect involved correction of deviations from the long run link with Hong Kong, with a lower speed of adjust.

2.3 Assessing Quantitative Easing Policy of the United States.

After the global financial crisis in 2008, The U.S. entered a deep recession, with nearly 9 million jobs lost during 2008 and 2009, roughly 6% of the workforce, Gross domestic Product (GDP) had decreased at 40%. Moreover, U.S. housing prices fell nearly 30% on average and the U.S. stock market fell approximately 50% by early 2009 (Johnson, Simon ,2013).While the usual policies are not achieved to restore the weak economy in particularly lowering the interest rate close to zero bound., Federal Reserve (Fed) has been used an unconventional monetary policy known as "Quantitative Easing(QE)" . Quantitative Easing was designed with the explicit purpose of stabilizing the national economy as well as boosting the weak asset market. The policy rate was lower and reached the burden thus, Fed has been implemented an unconventional monetary, QE, by buying financial assets including Treasuries, Agency bonds, Agency Mortgage Backed Securities (MBS) since 2008.

Nowadays, The U.S. conducted the QE programs as follows:

Table 2.1 Quantitative Easing Programs Announcements

	Event date		Event
QE1	1	25/11/2008	The Federal Reserve announces purchases of $100 billion in Government Sponsor Enterprise debt and up to $500 billion in MBS
	2	1/12/2008	Chairman Bernanke mentions that the Federal Reserve could purchase long term Treasuries.
	3	16/12/2008	Federal Open Market Committee (FOMC)first mentions possible purchase of long-term Treasuries.
	4	28/1/2009	FOMC statement says that it is ready to expand agency debt and MBS purchase, as well as purchase long-term Treasuries.
	5	18/5/2009	FOMC announces that it will purchase additional&750 billion in agency MBS and increase its purchase of

Table 2.1 Quantitative Easing Programs Announcements (continued)

		Event date	Event
			agency debt and long-term Treasuries by $100 billion and $300 billion, respectively.
QE2	6	3/11/2010	the Federal Reserve announces purchases of &600 billion of Treasury securities by end of the second quarter of 2011.
	7	13/7/2011	Chairman Bernanke says, "The federal Reserve is ready to ease monetary policy further if economic growth and inflation slow much more".
QE3	8	31/8/2012	Chairman Bernanke mentions that the federal is ready to additionally act, and purchase long term Treasuries.
	9	12/9/2012	The federal Reserve decides to launch a new $40 billion a month, open-ended, bond purchase program of agency MBS and also continue the extremely low rate policy until at least mid-2015.
	10	12/12/2012	FOMC decides to continue its purchase of agency MBS and longer-term Treasury securities at a pace of $40 billion and $45billion, respectively.
	11	22/5/2013	Federal Reserve Chairman Ben Bernanke tells Congress that the U.S. central bank could slow down its asset purchase program in the next few months.
	12	19/6/2013	Ben Bernanke says the Fed could begin to taper its purchase of bonds later this year, if the economy continues to improve as Fed officials expect.
	13	18/9/2013	The Federal Reserve holds its asset purchase program steady, putting off any decision for tapering until later in the year in a decision that surprises markets.

Table 2.1 Quantitative Easing Programs Announcements (continued)

	Event date	Event
14	18/12/2013	Fed announces plan to reduce monthly bond buying to $75 billion from $85 billion.
15	29/1/2014	Fed decides to further reduce its monthly bond purchases by $10 billion, to $65 billion

From (For event 1-5 (Neely, 2010 as sited in Cho and Rhee, 2013), Federal Reserve Board Homepage for event 6-10, www.marketwatch.com for event 11-13 and www.reuters.com for event 14-15)

According to table 2.1, there are several channels of QE operations which could affect to the economy. Joyce, Lasaosa, Stevens and Tong (2010) suggested 3 main channels which might affect to the economy. First is signaling channel (policy news), which come from the announcement of QE, information economic indicator and the reaction of FOMC. Krishnamurthy and Jorgensen (2011) found that the signaling channel lowered yields on intermediate and long term bonds as well as Bauer and Rudebusch (2013) found that it will also lower rates in all fixed income markets, because all interest rates depend on the expected future path of policy rates. Second is rebalancing channel, purchasing long term securities, could lower bond yield. However, Thornton (2012) found that there was no evidence that the decline in longer-term rates and term premiums come from the portfolio balance channel. On the Contrary, Falgiarda (2012) isolate a portfolio rebalancing channel of QE and found that QE have effects in term of lowering bond yield, and higher output and inflation. Third is liquidity channel, purchasing securities program of central bank, could reduce the premium on most liquid bond as well as interest rate. Herrenbrueck (2013) found that QE can reduce yield across the board and simulate investment because when central bank employ a monetary expansion, domestic interest rate will decrease, thereby attracting investment from domestic investors(Mishkin, 2007).

Moreover, there were many studies that found the impact of QE on the U.S. economy such as Chen, Curdia and Ferrero (2011) found the effects of QE on GDP and inflation are likely to moderate; Jarrow and Li found that QE effect to bond yields in all maturities; Moore, Nam, Suh and Tepper (2013), Christensen and Gillan (2013) also confirmed that bond yields on long maturity Treasuries and other securities declined on days of announcements that indicated the FED was planning to increase its holding of long term securities; Fratzscher, Duca and Strauband (2013) found that Fed measures in the early phase of the crisis highly effective in lowering sovereign yields and raising equity markets. Glick and Leduc (2013) found that QE had significant effects on the value of the dollar as well. According to Mudell-Fleming approach, an increase in money supply will reduce the local interest rate lower than global interest rate so, the hot money flows out to take advantage from higher interest rate in other countries, thereby depreciating U.S. currency.

According to above information, Quantitative Easing policy implementation means that the central bank injects the sufficient capital by purchasing the financial assets including Treasuries, Agency bonds, Agency Mortgage Backed Securities from domestic investor, financial bank and financial institution in order to add the liquidity and achieve the restoring weak national economy. However, there were some crucial side effects of this policy, namely, increasing the equity market, and increasing inflation .In addition, lowering the interest rate as well as bond yield in all maturities causes the capital outflow which lead to depreciation in U.S. currency.

Furthermore, QE does not only effects to the U.S. economy, but it also effects to the global economy, in particular emerging economies (EMEs). The impact of QE on EMEs has been studied by the work of Morgan (2011), Chen, Filardo, He and Zhu (2011), Chua, Endut, Khadri and Sim (2013), Cho and Rhee (2013), Fratzscher, Duca and Straub (2013) and Lim, Mohspatra, and Stoker (2014).) According to the introduction in chapter 1 , U.S. QE could lower emerging economies bond yields, increase stock prices and exert upward pressures on exchange rates against the dollar. Similarly to the channels which affect to the U.S. economy, Fratzscher, Duca and Straub (2013) provided 4 channels through which QE may affects to portfolio decision of internationally investors and asset price. First is a portfolio balance channel. QE reduces the supply of U.S. investors so, they will increase demand for other investment. Lim, Mohspatra, and Stoker (2014) expect that portfolio balance channel to be expressed both in term of demand for EMEs asset. Second is the signaling channel which comes from the Fed announcement. Cho and Rhee (2013) studied the event of QE announcement and found that it has effect to EMEs asset. Third is confidence channel can affect portfolio decisions and asset price by altering the risk appetite of investors. For instance, a QE announcement may be understood as indicating that economic condition are worse than expected, hence triggering to safety (Neely, 2010 as cited in Fratzscher, Duca and Straub ,2013). Finally, a fourth channel is liquidity channel. The asset purchased through QE operations could increase reserves on the balance sheet of private banks, so the bank can extend the credit to investors, including extending to EMEs (Lim, Mohspatra, and Stoker , 2014).

In conclusion, U.S. Quantitative Easing could effect of both domestic and international economies in various way. It also cause financial inflows to emerging economies through portfolio balance channel, signaling channel, confidence channel and liquidity channel. These channels, then, could affect to bond yield, exchange rate and stock markets in EMEs.

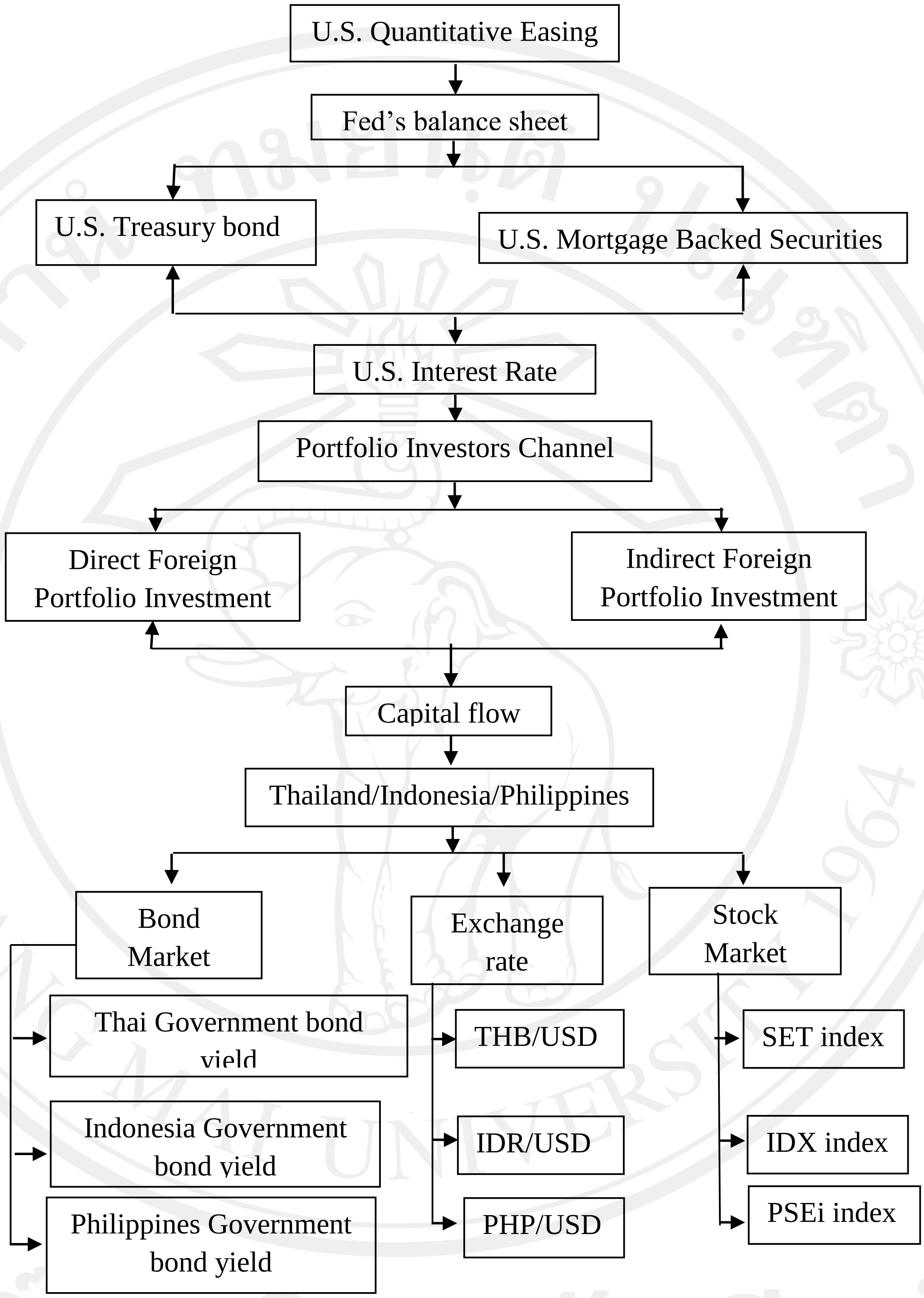


Figure 2.2 Quantitative Easing Monetary Policy's spillover effect mechanism