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Monetary policy effects of the United States and the euro area on the Chinese financial markets

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List of abbreviations

APP: Asset Purchase Program.

AREAER: Annual Reports on Exchange Arrangements and Exchange Restrictions.

BIS: Bank for International Settlements

CBT: Chicago Board of Trade.

CET: Central European Time.

CME: Chicago Mercantile Exchange.

CSI: China Securities Index.

DOTS: Direction of Trade Statistics.

ECB: European Central Bank.

EME: Emerging Market Economy.

EONIA: Euro Overnight Index Average.

EU: European Union.

FDI: Foreign Direct Investments.

FED: Federal Reserve System.

FOMC: Federal Open Market Committee.

GDP: Gross Domestic Product.

GEM: Growth Enterprise Market.

GFCF: Gross Fixed Capital Formation.

GMM: Generalized Method of Moments.

HKEX: Hong Kong Exchanges and Clearing Limited.

LSAP: Large Scale Assets Purchase.

LTRO: Long-Term Refinancing Operation.

MEP: Maturity Extension Program.

MRO: Main Refinancing Operation.

NCB: National Central Bank.

OECD: Organisation for Economic Co-operation and Development.

OLR: Ordinary Linear Regression

OLS: Ordinary Least Squares

QFII: Qualified Foreign Institutional Investors.

RMB: Renminbi.

RQFII: Renminbi Qualified Foreign Institutional Investors.

SEHK: Hong Kong Stock Exchange.

SMP: Securities Market Program.

SOE: State-Owned Enterprise.

SSE: Shanghai Stock Exchange.

SZSE: Shenzhen Stock Exchange.

TLTRO: Targeted Long-Term Refinancing Operation.

UIP: Uncovered Interest Rate Parity.

UNCTAD: The United Nations Conference on Trade and Development.

U.S.: United States.

VAR: Vector Autoregression.

Monetary policy effects of the United States and the euro area on the Chinese financial markets

Abstract

This paper documents and compares the effects of monetary policy announcements released by the United States and the euro area on Chinese mainland and Hong Kong stock markets. Using daily data, we apply the event study approach and the heteroskedasticity identification approach to carry out the empirical tests. We find a larger and more significant response from Chinese stock markets to U.S. monetary policy surprises than to the euro area monetary policy surprises. Meanwhile, we also notice a stronger reaction from the Hong Kong stock markets to shocks delivered by monetary policy decisions from these two areas, compared with the responsiveness of Chinese mainland stock markets. This paper also analyses and justifies these observations through five determinants to the international transmission of monetary policy effects: real economic integration, financial integration, exchange rate regime, openness of the economy and industrial composition. These findings suggest that, only considering monetary policy effects, international investors might create a diversified portfolio composed of assets in the stock markets of Mainland China and the euro area, and that the American monetary policy announcements could be considered as a risk to Chinese stock markets as well.

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Master Thesis

1. Introduction

For years, China has become one of the countries whose economy and capital markets have experienced the fastest growth in the world. According to MacNeil (2002), the total capitalization of Chinese mainland stock exchanges, namely Shanghai and Shenzhen stock exchanges, has reached over 50% of the gross domestic product (GDP) of this area. This permits the capital market of China to play a more important role in its economy, compared with most European countries except United Kingdom, confirmed by Maher and Andersson (2000). Meanwhile, Wang and Chin (2004) notice that more and more attention and participation of international investors has been grabbed by the impressive growth opportunities of the Chinese security markets. Global portfolio managers, in the opinion of Truong (2011), share and benefit from the development of the Chinese economy in a significant way, thanks to the gradual opening to the international investors of the Chinese capital markets in recent years.

In April 2017, the International Monetary Fund (IMF) communicated its updated world economic and financial surveys. It revealed that China became one of the top three largest economies in terms of nominal GDP, other than the United States (U.S.) and the euro area (EA) (International Monetary Fund, 2017). Looking at foreign direct investments (FDI) and trade in goods, the mutual relationship between China and the U.S. or the EA tends to be closer and more important. As a result, China becomes their most important financial and commercial partner (Office of the United States Trade Representative, n.d.; European Commission, 2017).

It is obvious that the U.S. and the EA both have a significant influence on the global economy. Many papers contribute to the study in this subject. In contrast, there are few of them concentrating particularly on the effects that the U.S. and the EA have on Chinese markets, even though the interaction between China and these two areas in terms of trade in goods and FDI in stock markets tends to be more frequent and important. That is why we would like to fill in this gap with this thesis.

Bjørnland & Leitemo (2009) study the interdependence between monetary policy and stock price in their paper. They reveal that monetary policy seems to influence stock prices, because the latter are supposed to be determined in a forward-looking manner and the former mainly works on interest rates whose surprising moves will have an effect on discount rates used by firms and stock return premiums requested by investors. Meanwhile, Chatziantoniou *et al*. (2013) point out that interest rates manipulated by monetary policy can encourage market participants and companies to make investments. It impacts net cash flows of companies through the cost of capital and credits delivered by banks. As illustrated above, China's capital markets have been developing for years. Its role in the international capital market becomes nowadays considerable. A study of the relationship between the American or the European monetary policy on Chinese financial markets as a result could be one of the most immediate ways to measure the influences of the U.S. and the EA on China.

Besides, it can also be an interesting topic for several other reasons. Firstly, from the perspective of financial market participants, studying the effects of U.S. and EA monetary policy on Chinese financial markets could help to determine whether their policy announcements should be considered as a risk factor when making investment decisions in China. Furthermore, it is useful to examine the possibility to build a diversified portfolio with assets in the markets of these three areas in order to avoid an unsupportable risk as well. Secondly, for a Chinese related official organization or institution, it could be an interesting topic. Outstanding effects would suggest a Chinese authority paying more attention to the monetary policy communicated from other countries, especially the two most powerful economies in the world. An appropriate reaction to the surprising monetary policy announcement would then be required. Analyses on the transmission channels of these effects will be helpful to protect Chinese domestic capital markets from policy shocks originating from other countries. Thirdly, it could draw attention of an American or European monetary policymaker on it too. Having an estimate of the responsiveness of China's financial markets to their monetary policy could be a critical step in formulating their policy decisions, since their economies and financial markets are much more linked to each other than before.

Therefore, we would like to achieve several goals with this paper. The first should be to get accurate estimates of the effects of U.S. and EA monetary policy on China's capital markets, in particular Chinese stock exchanges. The second is to figure out which factors can determine the level of these effects through comparisons among different Chinese stock exchanges.

To address these issues, we will utilise two approaches in this thesis: the event study approach and the heteroskedasticity identification approach. For the first one, we have to assume that the monetary policy shock is so large that it dominates all other shocks in the system. There are no further changes being expected within the month. The shock of monetary policy can be fully captured by an ad hoc window size around the selected policy announcements. On the contrary, only a weaker assumption needs to be made for the implementation of the second approach. It is assumed that the variance of monetary policy shocks increases and becomes relatively more important on the days when a policy decision is announced to the public. However, other shocks in the system still occur but remain invariant. These two approaches are both widely applied in the papers of studying effects of monetary policy. The application of two models allows us to ensure the robustness of the estimates measured through empirical tests in this thesis.

The thesis will proceed as follows. Section 2 describes the three main Chinese stock exchanges. It aims to provide us some background on China's capital markets to better understand the analysis of monetary policy effects later on. Section 3 explains the evolution of the monetary policy in the U.S. and the EA respectively. There are many similarities in the composition of the organizations and monetary policy tools between them, while lots of differences can also be demonstrated. Afterwards, previous studies on effects of respectively the U.S. and the EA monetary policy are covered in Section 4. It builds a theoretical framework of both the event study approach and the heteroscedasticity identification approach, as well as the determinants to the international transmission of monetary policy effects. Subsequently, Section 5 implements the empirical tests by applying the two approaches mentioned above to obtain an estimation of the effects. It interprets and compares the obtained results in order to identify the monetary policy possessing a larger spillover of effects and the stock exchanges more sensitive to the outside policy shocks. In this section, some interest rate future contracts are introduced as well. In Section 6, we discuss the determinant factors of the U.S. and the EA monetary policy effects on Chinese capital markets, where a specific policy by the Chinese government called the "One Country, Two Systems" is applied. It compares Mainland China and Hong Kong from the points of view of real economic integration, financial integration, exchange rate regimes, openness of the economy and industrial compositions. Finally, some conclusions and also deficiencies to the research are discussed in Section 7.

2. Chinese stock markets

China which is talked about in this thesis from now on refers to Greater China, namely Mainland China, Hong Kong, Macau and Taiwan. Because of the application of the principle "one country, two systems", Hong Kong, Macau and Taiwan are all considered as a special administrative region of China, without regard for political problems between governments of Mainland China and Taiwan. Their markets as a result show distinctive features compared to Mainland China. Thus, in order to figure out and compare the different influences of U.S. and EA monetary policy on Greater China under two systems which are communism and capitalism, we would like to focus our study on equity markets in Mainland China and the special administrative regions of China.

2.1. Markets in Mainland China

Ma *et al.* (2013) disclose that Mainland China's stock market is not yet mature, even though several important reforms have been carried out to make it more efficient. It is still easily influenced and fluctuates sharply. In order to protect the market from a suddenly large change in prices, a price limit was applied on December 16th, 1996. Today, the Mainland China market consists of two official exchanges: the Shanghai Stock Exchange and the Shenzhen Stock Exchange. Both are supervised by a Chinese entity: China Securities Regulatory Commission (CSRC) which was established in 1992 under the direction of the State Council.

2.1.1. Shanghai Stock Exchange (SSE)

In 1891, Shanghai already had a place to trade stocks and allowed local companies to raise funds through the Shanghai Share Broker's Association and later the Shanghai Securities and Commodities Exchange in 1919. But both of them closed due to political reasons and it is finally on December 19th, 1990 that the SSE reopened. On May 31st, 2017, with 1328 listed companies and a total stock market capitalization of ¥ 29,778 billion, which equals to $ 4,370 billion, the SSE remained the 4th biggest financial market in the world (SSE, 2017).

The SSE offers bonds, stocks, funds and derivatives to investors. Its objectives are to create a marketplace which is open, efficient, secure and transparent through its different functions which go from the general management and publication of market information to the creation and arrangement of public listings. It also takes a role in the securitization of trading and the regulation of members.

If we take a deeper look at its products, we notice that there is a classification of stocks which is mainly composed of A-shares and B-shares. The first type of shares, denominated A or RMB common shares, concerns local shares. They are reserved for the domestic market, meaning that they are issued by domestic companies located in China and traded by individuals or local institutions. There is an exception for foreign investors who can trade this kind of shares if they have acquired the title of Qualified Foreign Institutional Investors (QFII). The second type of shares, denominated B or RMB special shares, are about stocks of which pair value is indicated in RMB, the Chinese currency renminbi, and traded in other currencies, more designed for foreign investments (SSE, 2015).

2.1.2. Shenzhen Stock Exchange (SZSE)

The SZSE emerged officially on December 1st, 1990, but opened on July 3rd, 1991, and is similar to the SSE in some ways. It has the same objectives as the management of trades and their security. It offers the same products which are equities, bonds, funds and asset-backed securities, and if you are an international investor, you also need the title of QFII. If we look closer, we notice that the SZSE only offers national products (A-shares and B-shares) as well as the SSE considering other products such as H, J, L, N, and S-shares traded abroad Mainland China (SZSE, 2013). However, the B-shares are denominated with HK-Dollar on SZSE, while those on SSE are priced in US Dollar (Yao *et al*, 2014).

Besides, SZSE has also its own particularities as the second stock exchange in Mainland China. It puts in place a framework of multi-tiered capital markets in order to serve national economic development and transformation and support the national strategy of independent innovation, which responds to the needs of the Chinese capital market in its emerging and transitional stage (SZSE, 2013).

According to SZSE (2013), this multi-tiered capital market system is composed of the Main Board, SME Board and the ChiNext Market. The two unique segments of SZSE, namely SME Board and the ChiNext Market were respectively setup in 2004 and 2009. The former is exclusive to companies considered as small or medium, related to the high-tech or innovative industries, having a stable profitability, and which has high growth potential (SZSE, 2013). The latter aims to establish a capital market platform for the development of first start-ups, especially independently innovative enterprise and other growing venture enterprises (SZSE, 2013). Both of those boards are independent with their own rules and offer different types of risks to investors looking for diversity.

On May 31st, 2017, the SZSE was evaluated as the 8th largest financial stock exchange with its total number of 2015 listed companies and a total stock market capitalization of ¥ 21,584 billion, or $ 3,167 billion, for the main Board, the SME Board, and the ChiNext Market (SZSE, 2017).

The Mainland China stock market has been expanding with notable speed since the establishment of SSE and SZSE in 1990. It is completely order driven and automated. Both of its stock exchanges are capable of managing trades with high volumes. In order to stabilize equity markets, a daily price limit of 10% was set by the CSRC and applied on all common stocks. Concerning the settlement, it is T+1 for local currency traded securities, which is shorter than the settlement cycle with T+3 for trades of B shares. (Yao *et al*, 2014)

2.2. Markets in special administrative regions of China

As we have mentioned earlier, there are three special administrative regions in China: Hong Kong, Macau and Taiwan. However, Macau does not develop its own securities exchange even though its government planned to build one in the beginning of the year 1990. Its economy is too small to attract foreign investment outside the gambling industry. The Taiwan Stock Exchange was established more than fifty years ago. At the end of 2016, it consisted of about 900 listed companies with a market capitalization equivalent to TWD 27.25 trillion (TWSE, 2016). Nonetheless, considering the political problems between governments of Mainland China and Taiwan and also the important role of Hong Kong in the international financial markets, we prefer to take Hong Kong Stock Exchange (SEHK) as a representation of these three special administrative regions and compare it with the Mainland China stock exchanges.

The origin of SEHK came from the creation of the Association of Stockbrokers in 1891. This association was renamed to SEHK in 1914 and then kept this name despite of the merger with the Hong Kong Stockbrokers Association in 1947, and with the Far East Exchange, the Kam Ngan Stock Exchange and the Kowloon Stock Exchange in 1986 (HKEX, 2017).

Today, the SEHK is a wholly-owned subsidiary of the group Hong Kong Exchanges and Clearing Limited (HKEX) which is one of the largest financial market operators in the world. Since the group aims to connect China with the world, the SEHK introduced the Shanghai-Hong Kong Stock Connect Plan with CSRC in 2014. This system allows international investors to enter into the Chinese financial market without having specific licenses QFII or Renminbi Qualified Foreign Institutional Investors (RQFII). Consequently, SEHK becomes a transitional place of exchanges between international markets and the Mainland China markets (Raine & Adams, 2015).

In order to provide more funding opportunities, SEHK introduced Growth Enterprise Market (GEM) as an alternative market of the main board in 1999. This new market targets growth companies of all sizes, from all industries which do not meet the requirements of the main board concerning their profitability or track record. However, it applies a strong disclosure regime which follows the philosophy: Greater, More Frequent and Timely to minimize the risk of investments and ensure the rights of investors. (Growth Enterprise Market, 2017)

The whole SEHK, including the main board and the GEM, represented 2027 listed companies and a total stock market capitalization of HKD 28,541.7 billion ($ 3,662 billion) at the end of May 2017. As a result, SEHK became the third largest stock exchange in Asia and arrived at the 6th rank among the world largest stock markets according to its market capitalization (HKEX, 2017).

3. Monetary policy of the United States and the euro area

A monetary policy is a measure decided by a federal authority, such as a central bank, which will have different effects on the economy, for instance, on interest rates through releasing a certain amount of money on the market or sharing with the public its growth rate objective. Its ways of actions are diverse, from changing the interest rate in order to stimulate consumption, to providing money to the government through buying its bonds which can be considered as buying its governmental debts (Friedman, 1968).

3.1. Federal Reserve System

The institution responsible for the management of the American monetary policy is the Federal Reserve System, also known as the Fed. It takes the role of the central bank of the entire country. This American institution has fulfilled this role since 1913. The Federal Open Market Committee (FOMC), composed of twelve members, is the board which takes the decisions. Its members meet eight times per year and analyse the current economic situation. Based on this analysis, they determine the way they should put in place the new monetary policy in order to promote price stability and sustainable economic growth.

The Fed can use different tools such as the open market operations. They consist of buying or selling financial instruments to commercial banks and changing the level of reserve requirements imposed to banks. Both of them will influence the liquidity available on the market. The Fed can also directly manipulate interest rates by changing policy rates.

In addition to those classic tools, the Fed uses others to achieve its objectives as well. For example, the Term Deposit Facility allows the Fed to offer term deposits to eligible institutions. It consists in keeping the capital for a specified period, resulting in a diminution of their available reserves. Since there would be less available capital, those institutions would not be able to lend as much as before, and then the interest rates would increase. Another tool is the Overnight Reverse Repurchase Agreement Facility. Institutions buy Treasury securities and sell them the next day to the Fed. This kind of operations ensures the Fed to maintain a certain control on the liquidity of the market.

As observed in the literature (Chatziantoniou *et al*., 2013; Gali and Monacelli, 2005; Cwik *et al*., 2011), monetary policy is powerful, and to achieve their objectives, the Fed and other central banks have different tools at their disposition, which are conventional or unconventional.

Lorenzo Bini Smaghi (2009) considers those two tools, defined previously, as conventional. But due to strong perturbations, those tools may remain inefficient in abnormal time. Central banks need to act differently, such as applying unconventional monetary policy when considering extraordinary situations. It would create a large effect and restart the economic growth of a country or union.

During his lecture at the International Center for Monetary and Banking Studies in 2009, the former member of the executive board of the European Central Bank defines this kind of policy as measures which target external ways of financing for all agents of a society and their related costs. According to him, there is two major ways of modifying the cost of credit. One of them would be to use the reputation of a central bank to influence the behaviour of investors and their expectations over the long term, through general announcements for example. Another one concerns financial assets with different maturities. Two types of policy can be considered in this case as follows.

The first one is direct quantitative easing. In order to revitalize the market by injecting liquidity on it, the central bank will buy long-term government bonds from commercial banks and this operation will give new means to grant credits to investors. It is recommended to apply this policy only when the interest rate is low. Using the same system as for the quantitative easing, the so-called credit easing, quoted by Smaghi (2009), is used only on specific segments of the market, and not on all of it. In this case, the central bank does not purchase government bonds but asset-backed securities and corporate bonds. The real difference between those two policies is that the central bank is acting, in the latter case, as a commercial bank and invests directly in the economy. But doing so, it has to act carefully in order to respect the principle of the equal treatment to companies in the same sector.

Rogers *et al*. (2014) defines the Federal Reserve's Large-Scale Asset Purchase program, related to the purchase of mortgage-backed securities and longer-term Treasury securities, as an unconventional monetary policy as well. Buying long term securities had the purpose of increasing their price and diminishing their yield through a decrease in their relative supply. It has been observed in their paper that their announcement effectively had an impact on the market, especially on non-U.S. yields. The American monetary policy caused an appreciation of foreign currencies compared to the American dollar. But other parameters than monetary policy may affect these results, such as government bond issuance which magnified effects of the initial policy.

Once corrections have been observed on the market and the objectives of the central bank come in line again, going back to a normal situation in a proper way remains important and should not be neglected. Unwinding unconventional monetary policy needs to be cautious and steadily done in order to not disturb the market, for example through the selling of the significant amount of assets resulting from the quantitative easing (L. B. Smaghi 2009).

3.2. European Central Bank

In Europe, and more particularly in the EA, it is the European Central Bank (ECB) that decides which measures will be applied. The ECB is the centre of the European System of Central Banks and is an independent institution of which the main purpose today is to keep a price stability and an inflation level below, but close to two percent, in addition to the supervision of the proper functioning of credit institutions. Their ultimate purpose is to achieve a stable economic growth and jobs creation within the European Union. Composed of governors of countries located in the EA and six members of the Executive Board, the Governing Council is the one taking decisions regarding monetary policies and establishing guidelines in the interest of the realization of objectives. Members have to meet every six weeks and their announcements are broadcast to the public through regular accounts and press conferences (ECB, 2018).

Similarly to the FED, the ECB has different tools at its disposal when managing the European monetary policy. Open market operations, meaning that central banks directly invest on the market through purchasing or selling securities, gather a collection of conventional and unconventional monetary policy tools.

The main refinancing operations (MROs) are regular liquidity-providing reverse transactions which impact the short-term interest rates and liquidity on the market. Those transactions have a weekly frequency and maturity and are operated by central banks, which takes decisions according to a specific calendar. In order to be more effective over a larger period of time, long-term refinancing operations (LTROs) work on the same principles of the previous one, but with a usual maturation time of three months. It is possible for those liquidity-providing long-term refinancing operations to have a longer maturity, such as three years, and then they are considered to be unconventional. The targeted long-term refinancing operations (TLTROs), also unconventional, aims to finance specific credit institutions according to their lending activity. It will allow those banks to facilitate their lending activities which will stimulate the economy. Then there are the fine-tuning operations, intended to absorb effects of unexpected liquidity fluctuations through reverse transactions or exchange swaps, and structural operations which adjust the structural position central banks' longer-term facing the financial sector by issuing debt certificates.

In addition to the open market operations, the ECB has other tools such as one called standing facilities. This mechanism, separated into two categories, allows credit institutions to benefit from standing facilities and to absorb excess of liquidity resulting from the overnight operations. The marginal lending facility offers the possibility to credit institutions to obtain liquidity from National Central Banks (NCBs) by pledging assets as collateral. On the other hand, the deposit facility allows them to make overnight deposits. The system of minimum reserves can be combined with this previous tool. Requiring a minimum level to credit institutions ensures a certain level of economic stability for those institutions (European Central Bank, 2017).

Due to the extraordinary state of the financial market during the crisis, the ECB released its Asset Purchase Programmes (APP), which is considered an unconventional tool, to provide additional monetary stimulus. to economic activity in a low interest rate environment. It gathers a collection of purchase programmes, related to the acquisition of private and public sector securities designed to face risks of long period of low inflation (European Central Bank, 2017).

Other programmes, such as the Securities Market Programme, are now finished, but they have been used in the study led by Rogers *et al*. (2014) on unconventional monetary policy. In their paper, announcements are split into different categories and it appears that those related to LTROs and bond purchase had a significant effect on the European financial market. According to them, the public has noticed the strong willingness of the ECB to apply its APP and resulted in effects stronger than expected.

Institutions in charge of monetary policy have at their disposal powerful and various tools, in order to manage some difficult economic situations. And their influence may go beyond their own boundaries, as observed by some researchers.

4. Previous studies

4.1. U.S. monetary policy studies

The influence of U.S. monetary policy has always been a topic of great interest for economists, financial market participants and policymakers. Lots of studies have been carried out on its effects not only on the U.S. local market (Krueger & Kuttner, 1996; Kuttner, 2001; Rigobon & Sack, 2004; Bernanke & Kuttner, 2005; Gürkaynak *et al*., 2005 & 2007; Bjørnland & Leitemo, 2009; Wright, 2012), but also on the global markets (Craine & Martin, 2008; Ehrmann & Fratzscher, 2009; Wongswan, 2009; Hausman & Wongswan, 2011; Bowman *et al*., 2015; Pericoli and Veronese, 2017).

These papers study the U.S. monetary policy effects mainly through two ways: the event study approach and the heteroskedasticity identification approach. Despite different assumptions and dissimilar measurements in these two approaches, they all receive negative and highly significant estimates of U.S. monetary policy on local equity markets with a range from 1% to 2.5% for a move of 25 basis point in the interest rate. Concerning the effects on the international equity markets, they are as well as opposite to the shocks of the U.S. monetary policy. However, their estimates vary largely from one country to another country, which means that the propagation of effects can be significant to some countries, whereas the transmission of effects is limited to other countries.

In this section, we would like to review these previous studies on the U.S. monetary policy effects which are realized through respectively the event study approach and the heteroskedasticity identification approach.

4.1.1. <u>Event study approach</u>

The event study approach, which objective is to measure the U.S. monetary policy effects, is mainly composed of two factors: target surprise and path surprise. Its literature begins with Kuttner (2001) and Bernanke & Kuttner (2005), and is systematically developed by Gürkaynak *et al*. (2005).

After a set of researches on a various maturities and types of financial interest rate products and a comparison between their one-day and one-month responses to Fed funds surprises, Kuttner (2001) discloses that the market interest rate responses to the “surprise” component of Fed rate policy rather than to the change in the federal funds rate itself. If the policy actions are anticipated, the responses will be minimal. This observation is confirmed by a large number of following studies, such as Bernanke & Kuttner (2005), Gürkaynak *et al*. (2005), Wongswan (2009) and Hausman & Wongswan (2011). In the recent papers, the shock related to the move of federal funds rate is called "target surprise" and becomes one of the two major components in the equation of the event study approach, as illustrated in the preceding paragraph.

Bernanke & Kuttner introduced another essential component of the event study approach in the year of 2005, the path surprise. They analyse the reaction of equity markets to the monetary policy with a sample from the June, 1989 to the December, 2002. They mention that equity markets will also be impacted by the re-examinations of current expectations for future Fed policy that would follow these surprises. However, they don't model the computation of this second surprise and take it into consideration for testing the response of markets to Fed policy in their paper, which is dealt with by Gürkaynak *et al*. (2005) as follows, where ΔR_t is the returns in equity markets, and TS_t and PS_t respectively represent the target factor and the path factor.

$$\Delta R_t = c_0 + c_1\, TS_t + c_2\, PS_t + e_t$$

Since then, the event study approach has been popularly quoted by the subsequent papers, and the equation introduced by Gürkaynak *et al*. (2005) has become the basis model to identify U.S. monetary policy effects on equity markets, for example: Gürkaynak *et al*. (2007), Craine & Martin (2008), Ehrmann & Fratzscher (2009), Wongswan (2009), Hausman & Wongswan (2011) and Pericoli and Veronese (2017).

Furthermore, to reveal the international transmission of U.S. monetary policy effects to the Asia and the Europe, the event study approach has evolved through adding a third factor "Net of FOMC Effect Return" by Wongswan (2009) and Hausman & Wongswan (2011). They mainly use high frequency intraday data in a 30-min window to identify purer monetary policy effects. Due to the existence of time difference between U.S. and the Asian and European countries, the markets of the reporting economy are usually closed before FOMC publishes their announcements. Consequently, they have to apply the overnight return window which is computed from the closing price on the day of FOMC announcements to the next opening price in 30 min after the official opening time. Effects of other U.S. news unrelated to FOMC announcements might as a result be captured by the Asian and European overnight equity indexes as well. Thus, the factor "Net of FOMC Effect Return" is needed to eliminate influence of other U.S. news unrelated to FOMC announcements on the Asian and European overnight equity indexes.

Finally, the regression in the event study approach measuring U.S. monetary policy effects on the Asian and the European countries becomes the following:

$$R_t = c_0 + c_1\, TS_t + c_2\, PS_t + c_3\, S\&P_t^{Net} + e_t$$

where R_t, TSt, PSt and $S\&P_t^{Net}$ are the returns in equity markets, the target factor, the path factor and the factor "Net of FOMC Effect Return" respectively.

Having carried out empirical tests to identify the propagation of monetary policy effects through the event study approach, Kuttner (2001), Bernanke & Kuttner (2005), Gürkaynak *et al*. (2005), and Gürkaynak *et al*. (2007) all observed that U.S. monetary policy shocks influence the local markets in the opposite direction. Meanwhile, Craine & Martin (2008), Ehrmann & Fratzscher (2009), Wongswan (2009), Hausman & Wongswan (2011) and Pericoli and Veronese (2017) as well as disclosed the international propagation of U.S. monetary policy negative influence on equity markets. Even though it can only explain a small part of the move of local and international equity markets, they point out that shocks stemmed from U.S. monetary policy announcements should be still considered as a risky factor, even a global risky factor for the market participants when making investments decisions. In particular, Wongswan (2009) and Hausman & Wongswan (2011) argue that target surprise may have a more important role on the response of global equity indexes to U.S. monetary policy, while Pericoli and Veronese (2017) take into consideration the unconventional monetary policies and focus on the responses of the markets to path surprise.

4.1.2. Heteroskedasticity identification approach

Even though the event study approach becomes a typical way to measure U.S. monetary policy effects, considering the mutual influence between short-term interest rates and asset prices, which is confirmed by Bjørnland & Leitemo (2009), and the reactions of both interest rates and asset prices to numerous other factors, such as changes in macroeconomic outlook or risk preference, Rigobon & Sack (2004) recommend a new estimator based on the heteroscedasticity of monetary policy shocks to measure the response of equity markets. This new approach has already been introduced by Rigobon & Sack (2003) to assess the reaction of monetary policy to the stock market.

They firstly demonstrate that the two equations below measure changes respectively in the short-term interest rate and in an asset price:

$$\Delta i_t = \beta\, \Delta s_t + \gamma\, z_t + \varepsilon_t,$$

$$\Delta s_t = \alpha\, \Delta i_t + z_t + \eta_t$$

where Δi_t represents the change of the short-term interest rate, Δs_t computes the change in the asset price, z_t captures a set of other common variables which are omitted by the event study approach, and ε_t, η_t are respectively monetary policy shocks and asset price shocks.

Therefore, in order to analyse the response of equity markets to FOMC announcements, the estimated value of α in the equation of Δs_t, which reveals the impact of a change in the short-term interest rate on the asset price, has to be calculated.

By solving for the reduced form of the equations above related to the changes of respectively the short-term interest rate (Δi_t) and the asset price (Δs_t), Rigobon & Sack (2004) further get the two equations as follows:

$$\Delta i_t = \frac{1}{1-\alpha\beta}\, [(\beta + \gamma)\, z_t + \beta\eta_t + \varepsilon_t]$$

$$\Delta s_t = \frac{1}{1-\alpha\beta}\, [(1 + \alpha\gamma)\, z_t + \eta_t + \alpha\varepsilon_t]$$

Defining two sub-samples for announcement dates *(F)* and non-announcement dates *(˜F)*, the covariance matrix of the variables in these subsamples, $\Omega_F = E[[\Delta i_t\, \Delta s_t]'[\Delta i_t\, \Delta s_t] \mid t \in F]$ and $\Omega_{\tilde{}F} = E[[\Delta i_t\, \Delta s_t]'[\Delta i_t\, \Delta s_t] \mid t \in \tilde{}F]$, can be therefore identified by

$$\Omega_F = \frac{1}{(1-\alpha\beta)^2} \begin{bmatrix} \sigma_\varepsilon^F + \beta^2\sigma_\eta^F + (\beta+\gamma)^2\sigma_z^F & \alpha\sigma_\varepsilon^F + \beta\sigma_\eta^F + (\beta+\gamma)(1+\alpha\gamma)\sigma_z^F \\ . & \alpha^2\,\sigma_\varepsilon^F + \sigma_\eta^F + (1+\alpha\gamma)^2\sigma_z^F \end{bmatrix},$$

$$\Omega_{\tilde{}F} = \frac{1}{(1-\alpha\beta)^2} \begin{bmatrix} \sigma_\varepsilon^{\sim F} + \beta^2\sigma_\eta^{\sim F} + (\beta+\gamma)^2\sigma_z^{\sim F} & \alpha\sigma_\varepsilon^{\sim F} + \beta\sigma_\eta^{\sim F} + (\beta+\gamma)(1+\alpha\gamma)\sigma_z^{\sim F} \\ . & \alpha^2\,\sigma_\varepsilon^{\sim F} + \sigma_\eta^{\sim F} + (1+\alpha\gamma)^2\sigma_z^{\sim F} \end{bmatrix}.$$

for which, σ_ε, σ_η, and σ_z represent the variance of, respectively, the policy shocks, asset price shocks and other variables.

As Rigobon & Sack (2004) assume in this paper, the variance of other shocks remains unchanged while the one of the monetary policy increases on the date of FOMC announcements. Thus, the relationship of variances between these sub-samples can be expressed as follows:

$$\sigma_{\varepsilon}^{F} > \sigma_{\varepsilon}^{\sim F},$$

$$\sigma_{\eta}^{F} = \sigma_{\eta}^{\sim F},$$

$$\sigma_{z}^{F} = \sigma_{z}^{\sim F}$$

By consequence, α is able to be identified through the equation below:

$$\Delta\Omega = \Omega_{F} - \Omega_{\tilde{}F} = \frac{(\sigma_{\varepsilon}^{F} - \sigma_{\varepsilon}^{\sim F})}{(1-\alpha\beta)^{2}} \begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^{2} \end{bmatrix}$$

In other words, the change in the covariance of stock prices and short-term interest rates between announcement and non-announcement dates permits market participants to estimate the coefficient of interest α so as to identify the effects of monetary policy on equity markets, which can be implemented in two different ways: by instrumental variables and by generalized method of moments.

Secondly, Rigobon & Sack (2004) obtain a similar result as others who deal with the effects of monetary policy in event study approach that the increase of short-term interest rates will have a negative and significant influence on equity markets. However, they found that there is an upward bias in the event study estimates compared to the heteroskedasticity-based results. This finding is in line with Craine & Martin (2008). Nonetheless, both of them argue that the difference between the estimates of these two approaches for equity prices is not statistically significant. That is why they cannot formally reject the assumptions of the event study approach by the end of their papers.

Due to the weaker assumptions compared to those of the event study approach, the heteroskedasticity identification approach becomes more widely utilized in recent papers, especially those after financial crisis, such as Wright (2012) and Bowman *et al*. (2015). They focus on the spillover of unconventional monetary policy effects, seeing that more and more actions of the unconventional monetary policy, such as quantitative easing, large scale asset purchases (LSAP), maturity extension program (MEP) and operation twist, are utilised by the FOMC to counteract the effects of the financial crisis. In their opinion, the second approach should be more appropriate to capture monetary policy surprises to the markets, given that unconventional monetary policy does not work directly on Federal interest rates. However, Craine & Martin (2008), Wright (2012) and Bowman *et al*. (2015) also implement the event study approach with high frequency data in order to make a robustness check, by arguing that all other shocks might be negligible in this case.

Finally, Craine & Martin (2008) and Wright (2012) conclude with a significant influence of U.S. monetary policy shocks to their reporting economies. On the contrary, Bowman *et al*. (2015) remark that effects of U.S. unconventional monetary policy on sovereign yields are significant for most countries but differ across countries, while those on stock prices are statistically insignificant for all countries in their sample.

4.2. EU monetary policy studies

As the euro zone is also well-developed as a funding market and plays an important role in the world, the trends toward monetary policy effects result in the entrance of many European economists into this field as well, such as: Perez-Quiros & Sicilia (2002), Kim *et al*. (2006), Bohl *et al*. (2008), Filipozzi (2009), Kholodilin *et al*. (2009), Brand *et al*. (2010), Hussain (2011), Winkelmann *et al*. (2014), Rogers *et al*. (2014). They set out to evaluate the effects that ECB monetary policy decisions will generate in the EA and globally, considering that they are aimed to be applied in different countries with diverse financial situations and funding markets developed in dissimilar levels. (Winkelmann *et al*., 2014)

4.2.1. Event study approach

With the goal of analysing effects of the EA monetary policy, the method to capture ECB monetary policy surprises in the event study approach becomes as essential as that for impacts of FOMC announcements, such as Perez-Quiros & Sicilia (2002), Filipozzi (2009), Brand *et al*. (2010), Hussain (2011), Fratzscher *et al.* (2014), Rogers *et al*. (2014) and Haitsma *et al.* (2016).

To our knowledge, the event study approach seems to be applied for measuring the monetary policy effects of the EA firstly by Perez-Quiros & Sicilia (2002). Instead of concentrating only on ECB meeting days, they work on an examination with daily data on the move of the markets on ECB and non-ECB meeting days. Comparing the significance of the shocks produced between the meeting days and other days, they extract the reactions of markets to unexpected monetary policy decisions made by the ECB.

Brand *et al*. (2010) regroup the ECB monetary policy communications into two categories: news related to the level (and timing) of the interest rate (interest rate decisions) and news related to the future path of monetary policy (press conferences). Since they take the surprise of timing into consideration, which means participants may predict an interest rate move of a certain size, but they do not correctly anticipate the date of this move, Brand *et al*. (2010)

implement the analysis of ECB monetary policy effects with three factors: target factor, path factor and also timing surprise factor, on the basis of the study of Gürkaynak *et al*. (2005). The equation is showed as follows:

$$R_t = c_0 + c_1\, TS_t + c_2\, T_iS_t + c_3\, PS_t + e_t$$

where R_t is returns in equity markets, TS_t, T_iS_t, and PS_t respectively represent target surprise, timing surprise and path surprise.
Nonetheless, the equation of the event study approach consists of only one factor in the paper of Rogers *et al*. (2014) as follows:

$$R_t = \beta\, MPS_t + \varepsilon_t$$

where R_t is other asset returns in the window around announcements and MPS_t refers to the monetary policy surprise.

Rogers *et al*. (2014) focused on measuring the effects of unconventional monetary policies on asset-markets through a comparison over multi-countries, including the Federal Reserve, ECB, Bank of England and Bank of Japan. Because unconventional monetary policy does not work directly on policy rates, they argue that it is less meaningful to separate target surprise and path surprise. Instead, they quote the intraday change in government bond yields within a short window around the announcement as the monetary policy surprise.

In spite of different ways to implement the event study approach, Perez-Quiros & Sicilia (2002) and Brand *et al*. (2010) both find that ECB communicates their monetary policy decisions to the public in an appropriate way, resulting in a small percentage of meeting sample produces shocks to markets. In contrary, Brand *et al*. (2010), Hussain (2011) and Rogers *et al*. (2014) realize that ECB press conferences held directly after the release of monetary policy decisions might convey important and additional information resulting in a revision of market participants on future interest rates. The latter finding leads the European monetarists to focus on not only the release of ECB monetary policy decisions, but also the subsequent ECB press conferences, especially when they utilize intraday data for the selected ECB monetary policy announcements in the event study approach in order to eliminate market noise coming from non-monetary policy events. This is different from the papers measuring FOMC monetary policy effects through the event study approach.

By implementing empirical tests through the event study approach, Perez-Quiros & Sicilia (2002) disclose a limited effect of surprises on the stock market yield curve in the EA, especially when they are resulted from an ECB monetary policy meeting. In addition, if decisions are perceived to be temporary by market participants, effects on the bond yields will decline when the maturity of the bond becomes longer. However, Brand *et al*. (2010) indicate that shocks triggered by ECB press conferences concerning the future path of interest rate will have a statistically significant effect on the interest rate forwards with long maturity, while unexpected release of interest rate policy decision impact rather on the interest rate forwards with short maturity. Likewise, Haitsma *et al.* (2016) also observe a significant effect of the ECB monetary policy on the stock index. As they distinguish between conventional and unconventional monetary policies, they achieve different estimates. Conventional monetary policies have negative effects on equity markets before the crisis, while this sign changes in the period of the crisis. Related to non-conventional monetary policies, there will be reverse effects on the stock markets.

Regarding to the effects of ECB monetary policy announcements on the international markets, Hussain (2011) acquire a similar result to those of Wongswan (2009) and Hausman & Wongswan (2011) for global spillover of FOMC monetary policy effects. He figures out that equity markets in general do not respond to path surprise. Nonetheless, Fratzscher *et al.* (2014) find that ECB unconventional monetary policies, aiming to improve liquidity in the market, have a positive effect on equity prices in the EA. Moreover, these policy actions also impact positively global markets. There will be an increase of equity prices and a reduction of risk aversion and credit risk of sovereigns and global banks.

4.2.2. Heteroskedasticity identification approach

In order to handle the endogenous relationship between interest rates and stocks prices, Bohl *et al*. (2008), Kholodilin *et al*. (2009), Rogers *et al*. (2014) and Kucharčuková *et al*. (2016) investigate the ECB monetary policy effects relying on the heteroscedasticity identification approach recommended by Rigobon & Sack (2003, 2004). Bohl *et al*. (2008) and Kholodilin *et al*. (2009) focus on the propagation of ECB conventional monetary policy effects to the equity markets of the EA, Rogers *et al*. (2014) try to identify the domestic and international effects of the ECB unconventional monetary policy, while Kucharčuková *et al*. (2016) aim to compare the international transmission of effects related to ECB unconventional and conventional monetary policy announcements.

After their researches, Bohl *et al*. (2008) and Kholodilin *et al*. (2009) conclude that equity markets in the EA do react in an opposite way to the shock of the ECB conventional monetary policy decisions. This reaction is significant, immediate and uniform across the euro zone major stock markets. Meanwhile, it varies across the sectors with a range between 0.3% and 2.0% for a change of interest rate by 25 basis points.

On the contrary, Rogers *et al*. (2014) receive a different result from what they acquire through the event study approach. They find that by using the heteroskedasticity identification approach, domestic effects of ECB monetary policy are significant and lead an appropriation of the euro, although only for a short time. Concerning the global influence, Rogers *et al.* (2014) demonstrate that the spillovers of the effects related to monetary policy surprises are asymmetric. It is mainly transmitted from the U.S. to the non-U.S. area. Kucharčuková *et al.* (2016) prefer to discuss about the spillover of ECB monetary policy outside the EA, with a comparison between conventional and unconventional monetary policy. They find out that conventional monetary policy effects spread to their reporting markets in a similar way. However, effects of unconventional monetary policy are different across countries,

4.3. Determinants to the global spillover of monetary policy effects

Few papers continue to make efforts for the justification of their empirical results related to effects of the American and the European monetary policy. While there are still Bernanke & Kuttner (2005), Ehrmann & Fratzscher (2009), Wongswan (2009), Hausman & Wongswan (2011), Bowman *et al.* (2015), and Pericoli and Veronese (2017) providing explanations for the propagation of FOMC monetary policy effects to equity markets, only Houssain (2011), Fratzscher *et al.* (2014) and Haitsma *et al.* (2016) make several arguments to justify the ECB monetary policy effects' transmission. Among them, Ehrmann & Fratzscher (2009), Wongswan (2009), Hausman & Wongswan (2011) are the unique ones who explain systematically the potential determinants to the global spillover of monetary policy effects through implementing empirical tests.

According to Bernanke & Kuttner (2005), the monetary policy effects to domestic equity markets should be associated with expected future dividends and expected excess returns of holding stocks. Both of them are under the influence of participants' expectation about the future interest rate evolution and future economic activities which would be adjusted according to the signal delivered from monetary policy statements. This is also argued in the paper of

Hussain (2011) who explains that effects triggered by path surprise can be muted by the opposite revision in two components of equity prices: future cash flow and future discount rate and by Pericoli and Veronese (2017) who point out that the American and the European monetary policy surprises propagate through their own markets mainly by the financial channel.

Moreover, based on these observations, Ehrmann & Fratzscher (2009), Wongswan (2009) and Hausman & Wongswan (2011) provide evidence of real economic integration and financial integration of the U.S. to the reporting economies in determining the responsiveness of global markets to the FOMC monetary policy surprises. They show that the deeper the real economic and financial relationships are, the larger the response of the equity markets in the reporting economies will have. Likewise, Bowman *et al.* (2015) also examine the economic relationship between the U.S. and the reporting economies applying the ratio of exports to the U.S. to GDP. They notice that the reporting economies will respond more to shocks of U.S. monetary policy when they have a larger significant ratio.

Moreover, the sizes of response to monetary policy surprises will also depend on sectors of industries. Bernanke & Kuttner (2005) observe that riskier industries respond more strongly to shocks stemmed from the monetary policy announcements. In particular, high-tech and telecommunications sectors are affected more than other sectors such as energy and utilities. This is also applicable to investigate international effects of the American and the European monetary policy announcements on another economy. Wongswan (2009) and Hausman & Wongswan (2011) take them into consideration to justify why responses vary across countries.

Exchange rate regimes will be another important factor to consider, especially for global spillover of monetary policy effects, following Ehrmann & Fratzscher (2009), Wongswan (2009), Hausman & Wongswan (2011), Bowman *et al.* (2015) and Pericoli and Veronese (2017). Theoretically speaking, exchange rate regimes decide how exchange rates of a country response to the fluctuation of other currencies, and exchange rates have an impact on discount rates applied by firms in the reporting economies and also their expected future cash flow due to the change of competitiveness conditions of the exported goods. By consequence, exchange rate regimes have an influence to decide the responsiveness of the reporting economies to the American and the European monetary policy statements. Practically speaking, they all find that less flexible exchange rate regimes will result in stronger reactions of the reporting economies to the surprises of the American and the European monetary policy decisions after having carried out empirical tests.

Other factors are also mentioned. For instance, three drivers, namely current account deficits, GDP growth rates and vulnerability of banking sectors, which Bowman et al. (2015) utilise to explain the transmission of monetary policy shocks to the emerging market economies (EMEs). Through the empirical tests implemented in their paper, it is justified that EMEs with higher current account deficits, lower GDP growth rates, and more vulnerable banking sectors become more sensitive to U.S. monetary policy. In addition, Hussain (2011) also identifies three more transmission channels of monetary policy effects to equity markets, which are respectively perception of information communicated about future economic activities, adjustments of portfolio in multiple markets and also opinions of market participants, although he does not further explain his reasoning in the paper.

5. Statistical analyses

As we can see from the chapter “Previous Studies”, the majority of papers focusing on effects of FOMC and/or ECB conventional and/or non-conventional monetary policy on equity markets apply two common approaches, namely the event study approach and the heteroscedasticity identification approach. Especially for those after the U.S. financial crisis and the European sovereign debt crisis, the second approach probably becomes a trend to be used for assessing these effects.

In our paper, we would like to apply both approaches for reasons of robustness. Moreover, we also desire to distinguish between their advantages and disadvantages respectively through a comparison of their implementation.

Besides, we also would like to mention that all our data concerning the futures rates and index prices come from Bloomberg. Regarding monetary policy announcement dates, we consult the official sites of respectively Board of Governors of the Federal Reserve System and European Central Bank - Eurosystem as well as the papers of Dewachter *et al.* (2016) and Pericoli and Veronese (2017).

5.1. Event study approach

5.1.1. Data description

In order to more precisely capture the monetary policy surprises and the response of asset prices to monetary policy actions and statements, Gürkaynak *et al*. (2005), Wongswan (2009), Brand *et al*. (2010), Wright (2012) and Rogers *et al*. (2014), they all have set a small window. However, this kind of high frequency intraday data is not available for us since our sample period from 2005 to 2017 is extended wide beyond the proposal of Bloomberg from 2016 to 2017.

Besides, many economists, for instance: Krueger and Kuttner (1996), Kuttner (2001) and even Hausman & Wongswan (2011), also apply daily data in their paper. Moreover, despite of the usage of 30-minute window, Gürkaynak *et al*. (2005) also confirm in their work that the surprise component of monetary policy announcements can be measured very well using just daily data for the sample that begins in 1994 and that the estimated coefficients do not change a lot from the intraday to daily regressions of stock price changes on monetary policy surprises. The latter is reconfirmed by Hausman & Wongswan (2011) who compare their estimates of regressions based on daily data to those based on high frequency data realized in the study of Wongswan (2009). Moreover, Gürkaynak *et al*. (2005) mention in their paper as well that it takes some time for financial market participants to digest the policymakers' statements about the policy and economic outlook. Therefore, in contrast to target surprise which is instantaneous, path surprise is not immediately observable.

Having considered the non-availability of intraday data from 2005 to 2017 on Bloomberg using the scholar version, close results obtained through using intraday and daily data and also the observations of Gürkaynak *et al*. (2005) related to the market participants' digestion of policy announcements and economic outlook, then we have decided to use daily data in our paper.

5.1.2. Period of sample

The sample period in this paper goes from April 2005 to May 2017 for both U.S. and the EA, because the CSI 300 Index, the one that can reflect the performance and trends of the Mainland China A-share markets, wasn't launched until April 8^{th}, 2005 by the SSE and the SZSE jointly explained by Hou & Li (2014). For the capture of monetary surprises themselves, it includes all FOMC and ECB monetary policy announcements after their scheduled and unscheduled meetings. In addition, we add conference calls that have a press release after, several relevant speeches of, for instance, the presidents of FOMC and ECB, and a few of reports which can deliver a significant signal to the markets as well. Nonetheless, for the ECB monetary policy, seeing that the data of the involved futures prices are not available on the dates of 06/02/2005 (GC meeting), 05/09/2010 (GC meeting and Securities Market Program (SMP)), 08/07/2011 (SMP on Italy and Spain acknowledged by ECB), 04/15/2015 (GC meeting) and 03/09/2017 (GC meeting), we also have to remove them from our samples. In consequence, there are respectively 123 and 149 announcements of FOMC and ECB included in our samples for the identification of monetary policy surprises, which can be consulted in the Appendices I and II.

In contrast, relating to effects of monetary policy on the Mainland China and Hong Kong equity markets, we rebuilt the samples for these two markets based on the announcements considered above by taking away those which were released on or preceding their national holidays or weekends. Besides, we also have to drop the announcement dates which follow a national holidays or weekends. Regarding the policy announcements published in the successive days, only those released before others will be took into consideration. These last two selection criteria aim to protect the consistency of our samples for the equity markets in question from the event study approach part to the heteroscedasticity identification approach part.

As a result, the samples for the reaction of the Mainland China equity market to FOMC and ECB monetary policy shocks are composed of respectively 96 and 123 announcements, while those for the effects of FOMC and ECB monetary policy surprises on the Hong Kong equity market consists of 93 and 125 announcements. The numbers of announcements are not equal between Mainland China and Honk Kong, because they don't have an identical holiday system. A list of these announcements is reported in the Appendices III, IV, V and VI.

5.1.3. Measure of monetary policy surprises

As what Kuttner (2001) proposes after a set of statistical tests, market only responds to the surprises of monetary policy decisions. Furthermore, Gürkaynak *et al*. (2005) explain for the event study approach in their analysis that monetary policy surprises to the market must particularly be composed of two factors: target surprise and path surprise. Their conclusion shows that not only the surprise changes in the current target federal funds rate, but also the surprise changes in the expected path of future monetary policy will have an impact on the reaction of the market participants. If we only focus on target surprise, we will omit an important component of monetary policy decisions and get a biased observation of their effects on markets, especially when market participants have often fully anticipated target funds rate changes in recent years.

Though other factors are also suggested in some papers, for example timing factor in Brand *et al*. (2010) which identifies the shock related to the time of the real move in interest rate, or the factor "Net of FOMC Effect Return" in Wongswan (2009) and Hausman & Wongswan (2011) that aims to eliminate effects of other important news but unrelated to FOMC announcements on equity markets for areas outside U.S., we prefer to apply the model introduced by Gürkaynak *et al*. (2005) in our paper. The essential reasons are the need of intraday data by these factors and the popular citation of the model introduced by Gürkaynak *et al*. (2005) in this field.

a) Target surprise

(i) FOMC announcement target surprise

Even though expectations of monetary policy decisions cannot be directly observed, according to Krueger and Kuttner (1996) and Kuttner (2001), 30-day Fed funds futures prices can be introduced as a market-based proxy for those expectations so as to compute the target surprise of monetary policy announcements. This is supported by the efficiency of the 30-day Fed funds futures market, found by Krueger and Kuttner (1996), to anticipate the future fed funds rate.

Thus, Wongswan (2009, p.346) says that « *target surprise is the difference between the announced target federal funds rate and expectations derived from fed funds futures contracts* ».

30-day Fed funds futures are financial contracts which «*represent the average daily fed funds effective rate for a given calendar month as calculated and reported by the Federal Reserve Bank of New York. It is designed to capture the market's need for an instrument that reflects Federal Reserve money policy. »,* explained by the CME Group (2008, p.1). Besides, they are traded on the Chicago Board of Trade (CBT). The contracts can be cash settled. Banks and investors can hedge against unexpected moves in short-term interest rates with them. Since Fed funds futures are quoted with the discounted price from par, its rate should be computed from 100 minus its price. (Keasler & Goff, 2007)

Seeing that Fed funds futures rate is based on the average effective fed funds rate instead of the rate on any specific day, Kuttner (2001), Wongswan (2009) and Hausman & Wongswan (2011) suggest adjusting the change in current-month Fed funds futures rate with the number of days in the month affected by the monetary policy concerning the change of the fed funds rate to compute the target surprise. Moreover, Kuttner (2001) also explains that the expected change on date t should already be reflected by the futures rate on date t-1. If no surprise related to the change of the target fed funds rate occurs, no change of the Fed funds futures spot rate will take place. Otherwise, if the change does not happen as expected, the Fed funds futures rate will not remain unchanged. Consequently, he gives the formula below for the computation of target surprise on date t, for which $\Delta\tilde{r}_t^u$ is the adjusted unexpected change of target fed funds rates, namely target surprise, *m* represents the number of days in the month when there is a FOMC meeting, $f^0_{s,t}$ and $f^0_{s,t-1}$ respectively equal to the current-month 30-day Fed funds futures rate on date t and date t-1:

$$\Delta\tilde{r}_t^u = \frac{m}{m-t}\left(f^0_{s,t} - f^0_{s,t-1}\right) \qquad (1)$$

For instance, about the FOMC announcement communicated on September 20th, 2005, the current-month 30-day Fed funds futures should be the ones expiring in the month of this announcement whose expiry date thus is the September 30th, 2005. In order to compute the target surprise of this announcement, we then have to quote the rates of these contracts on September 19th, 2005 (namely: $f^0_{s,t-1}$, the rate of the contract on the day before the announcement) and also on September 20th, 2005 (namely: $f^0_{s,t}$, the rate of the contract on the day of the announcement). As Fed funds futures are only evaluated with prices in the market, we obtain rates computed from 100 minus prices. Since the prices on these two days are respectively 96.395 and 96.39 in Bloomberg, the change of the rate ($f^0_{s,\,t}$ - $f^0_{s,\,t-1}$) due to the monetary policy announcement will be as follows:

$$((100 - 96.39) - (100 - 96.395)) = 0.005$$

Moreover, since there are 30 days in September, *m* equals to 30. Meanwhile, *t* should have the value of 20 as it happens in the 20th day of the month. Then there are 10 days (30-20), the number of days related to the rest of this month, affected by the announcement. Consequently, the adjusted target surprise ($\Delta\tilde{r}_t^u$) should be:

$$\Delta\tilde{r}_t^u = \frac{30}{10} * 0.005 = 0.015$$

which means that the difference between the decision made by FOMC and the expectation of investors about current fed funds rate is positively around 0.015%.

Besides, when the value of *m* minus *t* is small, sometimes even close to zero, the adjustment factor for the change of current-month 30-day Fed funds futures rate on date t will be large. This could probably magnify changes in bid-ask spreads or other factors which are also able to impact futures' prices according to Hausman & Wongswan (2011). In order to avoid this problem, they suggest assessing the target surprise with the unadjusted change of the next-month Fed funds futures rates for FOMC monetary policy decisions announced in the last seven days of the month.

The usage of the following month futures contracts is also confirmed by Keasler & Goff (2007). They argue that there is little impact of the FOMC announcements, which occur after the middle of the month, on the price of the current-month futures, given that current month pricing has already included the realized fed effective rates. In contrast, the next-month Fed funds futures can more fully express the expectations of market participants. Therefore, the formula becomes as below for the FOMC announcements released in the last seven days of the month:

$$\Delta\tilde{r}_t^u = (f^0_{s+1,\,t} - f^0_{s+1,\,t-1}) \qquad (2)$$

where $f^0_{s+1,\,t}$ represents the next-month Fed funds futures rate on the day of the announcement, and $f^0_{s+1,\,t-1}$ represents the next-month Fed funds futures rate on the day before the day of the announcement.

For example, FOMC released a statement on January 28th, 2009. Since it was an announcement in the last week of the month January, we have to apply the Equation 2. In this case, the next-month Fed funds futures contract is the contract with a maturity date in February 2009. As showed in the example before, we thus quote the prices of the 30-day Fed funds futures from Bloomberg, expiring in February 2009 on January 27th, 2009 and January 28th, 2009. Because of the same prices equivalent to 99.79 on both days, the target surprise ($\Delta\tilde{r}_t^u$) will be equal to:

$$\Delta\tilde{r}_t^u = (99.79 - 99.79) = 0$$

which means that market participants have fully anticipated the fed funds rate decided by the FOMC members.

With the usage of the equations explained above, we have obtained the evolution of the target surprise concerning FOMC announcements within the period of our sample as the Figure 1 shows below. The computation details of target surprise for each FOMC announcement is reported on the Appendix I.

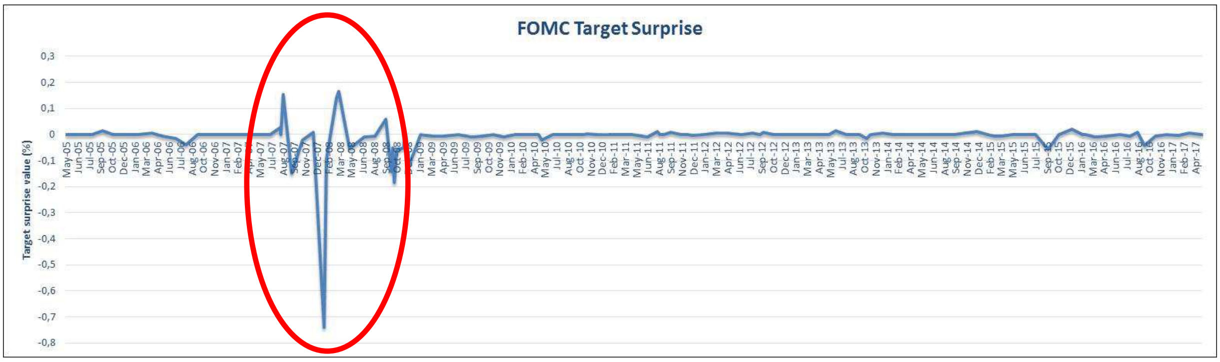


Figure 1: Evolution of the FOMC Target Surprise

From this figure, we can see that FOMC target surprise fluctuates the most during the financial crisis, especially an extreme negative surprise in the year 2008 compared to others. If we consult the Appendix I, we find that it is related to the announcement released on January 22nd, 2008 after the conference call on January 21st, 2008. It concerns a first decrease of the target fed funds rate about 75 basis points after the launch of a series of short-term credits in the funding markets against the financial crisis exploding in 2007. FOMC made this decision to respond to the view of a weakening of the economic outlook in the market and the deterioration of the financial market conditions (Board of Governors of the Federal Reserve System, 2008). However, the figure demonstrate that the level of this decrease was so large and sudden that investors had not anticipated it completely before.

(ii) ECB announcement target surprise

Similar to that of FOMC monetary policy, target surprise of ECB monetary policy announcements can be tracked from some money market derivatives as well. Filipozzi (2009) has implemented a study on this and declared that 1-month Eonia futures is similar to 30-day Fed funds futures which is considered as the best proxy of benchmark rates expectations in the U.S.. Since we have used 30-day Fed funds futures to compute target surprise of FOMC announcements as many other researchers do in their papers, we decided to use 1-month Eonia futures for ECB announcements target shocks to maintain the consistency of the paper.

1-month Eonia futures is a new financial instrument created by Eurex in January of the year 2003. It is based on the monthly average of the Eonia (Euro Overnight Index Average) reference rate which is the rate for overnight transactions in the interbank market and calculated by ECB each month. The minimum movement of Eonia futures' price is 0.005 percentage points. On the day of delivery, it can be settled by cash. Market participants often utilize it to hedge the short-term interest rate risk, because they can fix the interest rate in advance for the euro they need in a future specific day. Besides, rates included in an Eonia futures contract should be calculated from 100 minus its prices.

Seeing the similar characteristics between Eonia futures and Fed funds futures, pursuing the consistency of the paper and ensuring the comparability between monetary policy of FOMC and ECB, we have to deal with target surprise of ECB announcements in the same way with that of FOMC announcements. In other words, we have to compute the change of rates related to the current 1-month Eonia future contracts with an adjusted factor (Equation 1) in normal cases. Nonetheless, for ECB announcements released on the last seven days of the month, the next-month 1-month Eonia future contract prices will be used to capture the target surprise without the need of an adjusted factor (Equation 2). The evolution of target surprise of ECB announcements during our sample is illustrated in the Figure 2. Regarding the detailed computation, the Appendix II can be consulted.

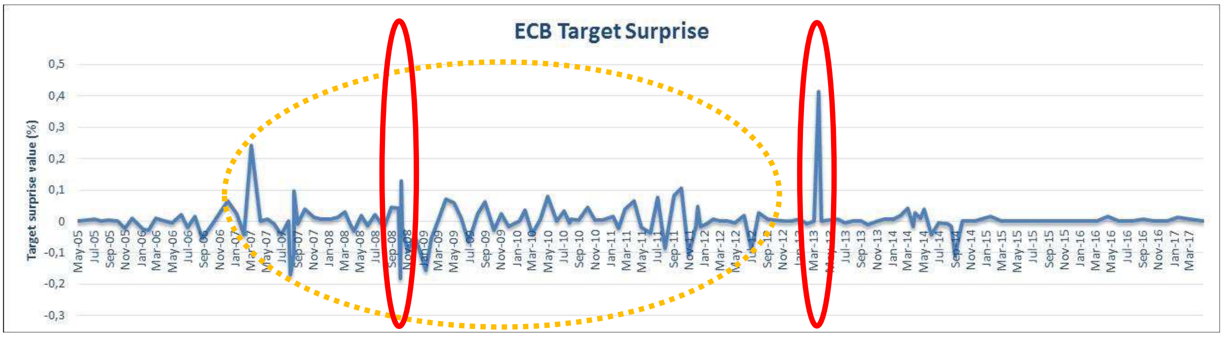


Figure 2: Evolution of the ECB Target Surprise

Firstly, the figure shows us that the extreme positive surprise happens on March 22th, 2013 on which date ECB announces to change collateral rules for certain uncovered government-guaranteed bank bonds. According to this announcement, uncovered government-guaranteed bank bonds issued by the counterparty itself or an entity closely linked to this counterparty are not accepted as collateral in Euro system monetary policy operations, neither covered bonds issued by the counterparty for which the asset pool contains uncovered government-guaranteed bank bonds mentioned above (European Central Bank, 2013). This could be considered as a signal to the market that ECB tends to tighten the issuing of credits which, as a result, leads to a review of market participants on interest rates with an upward outlook.

Secondly, the extreme negative surprise can be observed on August 10th, 2008. In order to fight against the financial crisis which exploded in U.S. but expanded to the world later, ECB cooperates with several central banks and takes unprecedented actions. Through a call conference, they decide to reduce the interest rate by 50 basis points with immediate effect. The suddenness of the decision-making and the rapidity of the implementation heavily shocked the markets, especially as there had been a trend for the interest rate to go up in last few years (European Central Bank, 2008). This observation is similar to FOMC target surprise which also meets a maximum negative surprise during the year 2008 when financial crisis exploded and expanded.

However, unlike the evolution of FOMC target surprise which becomes pale for the period after the explosion of financial crisis, target surprise delivered by ECB announcements enters into the period with the most fluctuations after U.S. financial crisis. In the end of 2009, the European sovereign debt crisis takes place, because several euro zone members, such as Greece, Portugal, Ireland, Spain and Cyprus, are assessed not to be able to repay their government debt (Lane, 2012). Due to the deterioration of financial conditions, measures taken by ECB become more difficult to anticipate. There are many unprecedented decisions released with the aim to safeguard the price stability and an appropriate transmission mechanism of monetary policy (European Central Bank, 2017).

b) Path surprise

(i) FOMC announcement path surprise

Based on the proposal of two proxies for monetary policy surprises by Gürkaynak *et al*. (2005), Wongswan (2009) and Hausman & Wongswan (2011) carry out a work on the effect of monetary policy surprises not only on the target surprise, but also on the path surprise. They define that path surprise is « *intended to proxy for news that market participants have learned from the FOMC's statement about the expected future path of monetary policy over and above what they have learned about the level of the target rate » (Wongswan, 2009, p.346).*

Thus, in order to compute the path surprise, Wongswan (2009) introduces the 3-month Eurodollar futures which are financial futures contracts traded at the Chicago Mercantile Exchange (CME). They are based on Eurodollar Time Deposits that denominated in U.S. dollars at commercial banks outside the U.S.. Specifically, they are derivatives on the LIBOR rate paid on those deposits in interbank transactions. The majority of them are quarterly contracts with a maturity in the months of March, June, September and December. Besides, Eurodollar futures can work as a tool for investors to hedge fluctuations in US dollar short-term interest rates for the reason that they can lock an interest rate today for the money that investors tend to borrow or lend in the future. As demonstrated by CME Group (2017), the rates of Eurodollar futures, namely the result of 100 minus the prices of Eurodollar futures (the same computation for the rates of Fed funds futures), can reflect market expectations concerning interest rates on 3-month Eurodollar Time Deposits for specific dates in the future. Therefore, they can also be considered as a tool to express investors' view on future interest rate moves.

Moreover, Wongswan (2009) explains as well that the path surprise can be one component of the change in 1-year-ahead Eurodollar interest rate futures on the day of the release of announcements and that it should be uncorrelated with the target surprise.

Concerning the 1-year-ahead Eurodollar interest rate futures, they will be the 3-month Eurodollar futures with a maturity in March of the year 2004 if we take the example of the FOMC announcement communicated on March 18th, 2003. Theoretically, 1-year-ahead Eurodollar interest rate futures refer to 3-month Eurodollar futures which will expire one year after the release of FOMC announcements. Nonetheless, Eurodollar futures have a maturity only in March, June, September and December. In our paper, we thus quote prices of Eurodollar futures with a maturity in March for FOMC announcements released between January and March, June for ones issued between April and June, September for ones published between July and September and lastly December for ones communicated between October and December.

For the reason that Eurodollar interest rate expresses the expectation of investors on the interest rate in a future specific date as we discussed above, the price of 1-year-ahead Eurodollar futures in the day of FOMC announcements, namely in the day one year before its maturity, demonstrates the forecast of investors for the interest rate in one year. It is a long-term estimation which thus includes not only the current interest rate expectation, but also the expectation related to the evolution of interest rates. That's why the change of 1-year-ahead Eurodollar futures' rate between the days preceding and on FOMC announcements is able to show target surprise and path surprise of the market on monetary policy decisions.

Given the points above, Wongswan (2009) proposes the equation below to measure the path surprise of FOMC announcements, for which Δed is the change of interest rate in 1-year-ahead Eurodollar futures between the days preceding and on FOMC announcements, TS_t represents the target surprise of announcements and PS_t refers to path surprise which is the error term in the regression:

$$\Delta \mathrm{ed} = \alpha_0 + \alpha_1 \mathrm{TS_t} + \mathrm{PS_t} \qquad (3)$$

Since the path surprise is the error term in the equation above, we cannot work out it directly with target surprise obtained in the previous section. On the contrary, we first have to obtain an estimated ordinary linear regression (OLR) for changes in interest rate of 1-year-ahead Eurodollar futures. As showed by the equation above, the relevant target surprise delivered from the FOMC announcements should play a role of an independent variable. Secondly, we estimate changes in interest rate of 1-year-ahead Eurodollar futures on each day of FOMC announcements using the OLR created earlier. Finally, the path surprise can be computed as the difference between the real and estimated changes in interest rate of 1-year-ahead Eurodollar futures, for which the real changes can be sorted out with the historical close prices.

Dependant Variable	**Variables Entered**	**Adjusted R Square**
Interest rate change in 1-year-ahead Eurodollar futures	FOMC target surprise	0,136

	Unstandardized_Coefficients		
	β	Std. Error	Sig.
(Constant)	-0,007	0,007	0,34
FOMC target surprise	0,411	0,091	0

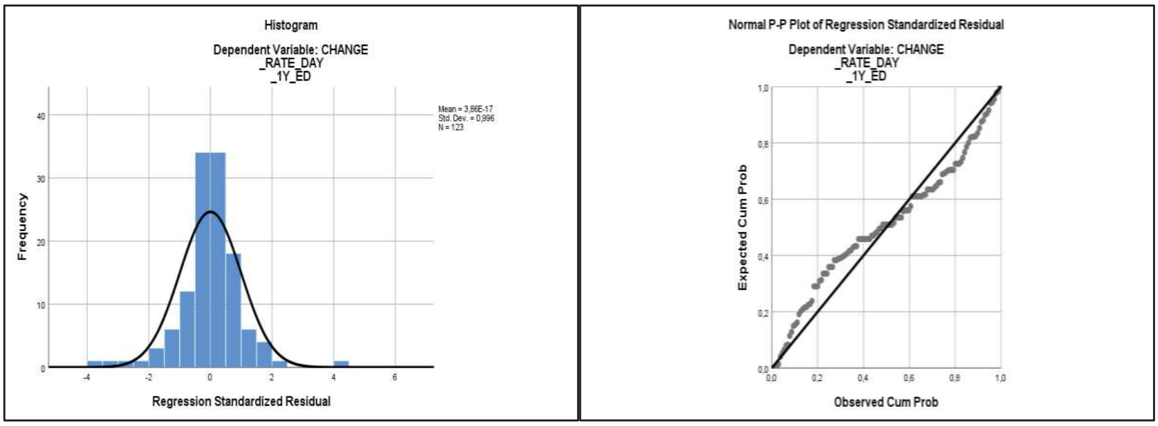


Figure 3: Regression of changes of 1-year ahead Eurodollar Futures

By using the SPSS software, we achieve results showed in the Figure 3 for the OLR of interest rate change in 1-year-ahead Eurodollar futures. The adjusted R squared value, which refers to the fitness of the regression, is equivalent to 0.136. It is larger than 0 but not close to 1. In addition, the frequency of the residuals conforms almost a normal distribution. Also, if we look at the P-P plot, the probabilities of observed sample residuals reveal a linear relationship with those of theoretical residuals. For which reasons, we can conclude that the error terms of this regression are quasi-normally distributed. Therefore, this created linear regression could be adequate, however, still some factors which probably also plays an important role in the determination of interest rate change in 1-year-ahead Eurodollar futures are omitted within the error terms. In the case of this paper, the omitted factor should be the path surprise.

Since the p-value of target surprise coefficient is 0, significant, and that the constant coefficient is so small even though it is not significant in the level of confidence 90%, we could estimate that the regression of changes of 1-year-ahead Eurodollar futures becomes as follows:

$$\widehat{\Delta ed} = \hat{\alpha}_0 + \hat{\alpha}_1 * TS_t = -0.007 + 0.411 * TS_t \quad (4)$$

We can now obtain path surprise by consulting the Equations (3) and (4). At first, with the access to Bloomberg, we can download historical close prices of 1-year-ahead Eurodollar futures for the days preceding and on the days of FOMC announcements to compute the real change of their rate. The data involved can be consulted in Appendix I. The related calculating operations will be similar to those of changes in Fed funds futures' rate before the timing adjustment. It means that real interest rate change of the 1-year-ahead Eurodollar futures on announcement dates is equal to the difference between the interest rate of the days preceding as well as on the announcements computed from 100 minus their price.

Taking again the example of the FOMC announcement released on the September 20th of 2005, since the close prices of the 3-month Eurodollar futures, with a maturity in September of 2006, are respectively 95.69 and 95.625 on the September 19th of 2005 (namely the day before the FOMC announcement) and on the September 20th of 2005 (namely the day of the FOMC announcement). The real change of Eurodollar futures' rate as a result is computed as below:

$$((100 - 95.625) - (100 - 95.69)) = 0.065$$

Secondly, we have to use the Equation (4) to acquire the estimated change of Eurodollar futures' rate due to the release of FOMC announcements. Consulting the Appendix I, we get 0.015 for target surprise. If we incorporate it in the Equation (4), we achieve:

$$\widehat{\Delta ed} = - 0.007 + 0.411 * 0.015 = - 0.000835$$

As path surprise is the error term which is the difference between the real and estimated change of the rate of the 1-year-ahead Eurodollar futures, for the FOMC announcement in our example it becomes consequently as below:

$$0.065 + 0.000835 = 0.065835$$

More computations of path surprise on other FOMC announcement dates in our sample can be consulted on the Appendix I.

If we compare the evolution of target surprise on FOMC announcements within the period of our sample to the evolution of path surprise, as illustrated by the Figure 4, we find that target surprise is normally paler than path surprise. This finding corresponds to the argument of Pericoli and Veronese (2017). According to them, FOMC announcements related to the target fed funds rate rarely become a surprise. However, the path component of monetary policy decisions plays an important role, especially when target fed funds rate becomes close to 0 after the financial crisis to restart the economic cycle. Target factor for monetary policy surprises becomes less relevant and interesting.

Nonetheless, if we look closer at the evolutions, for the announcement on the January 22nd of 2008 which FOMC decided a large decrease of fed funds rate by 0.75%, we achieve a bigger target surprise than path surprise. In our opinion, due to the deteriorating conditions on funding market, investors had already predicted a tendency of the decrease in the fed funds rate in the future. Despite this, they did not anticipate an immediate and huge decrease of Fed funds rate in that day since FOMC had launched an enormous amount of extra credits in the end of the year 2007 against the financial crisis.

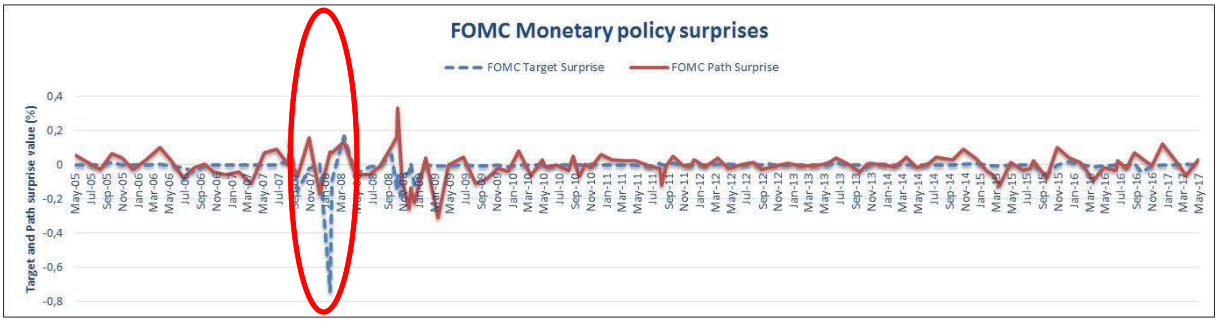


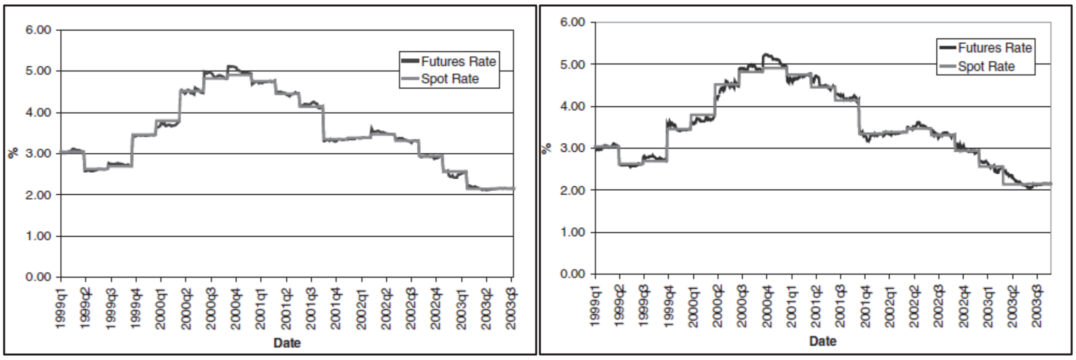
Figure 4: Comparison between Target surprise and Path surprise

(ii) ECB announcement path surprise

Reviewing the path surprise of FOMC announcements, it can be considered as the error term in the Equation 3 which estimates changes in the 1-year ahead 3-month Eurodollar futures rate taking the target surprise as an independent variable. Similarly, so as to extract path surprise from ECB announcements, we would like to find out a money market derivative for the EA which resembles Eurodollar futures to US dollars.

Bernoth & Hagen (2004) define Euribor futures as futures contracts whose underlying assets are Euribor deposits. Euribor is considered as the European money market reference rate for the unsecured market. Euribor futures exist various maturities. The most heavily traded futures are those in a 3-month maturity which expire normally in March, June, September and December. Similar to other interest rate derivatives mentioned earlier, 3-month Euribor futures interest rate equals to 100 minus their prices.

As the illustration of the figures below quoted from the paper of Bernoth & Hagen (2004, p7), Euribor futures rates track well the corresponding spot rates, especially when they are close to the delivering dates. Consequently, they comment that Euribor futures rates can be regarded as an unbiased predictors of future interest rates and their volatility might measure surprises triggered by central banks' policy decisions with an assumption of the efficiency in the market.



(Source: Bernoth & Hagen (2004), p7)

Figure 5: Futures rates with forecast horizon of 1-31 days (left) and 1-61 days (right)

Therefore, we select this 3-month Euribor futures to work with for assessing path surprise of ECB announcements. We first of all have to compute the change of 1-year ahead 3-month Euribor futures on the dates of ECB announcements in the same way as the computation of changes in 1-year ahead 3-month Eurodollar futures. The results can be consulted in the Appendix II. Then, by using the computed historical changes of 3-month Euribor futures and target surprise obtained through 1-month Eonia futures on the dates of announcements in our sample, we achieved the results of SPSS for the estimated OLR displayed on the Figure 6.

As the illustration on the figure, the adjusted R square value is only 0.019, which is small but still larger than 0. Given the assumption that only monetary policy announcements can influence interest rate futures contracts, a relative negligible R square value might reveal a more important role of path surprise in the determination of interest rate changes in 1-year-ahead Euribor futures which however is omitted in the regression and considered as an error term. The argument for the relatively more important dependency of interest rate changes on path surprise is also mentioned by the papers of Pericoli and Veronese (2017). Furthermore, the quasi-normal distribution of residuals in the histogram and the approximatively linear relationship between the theoretical probabilities and the sample probabilities of residuals in the P-P plot support the condition of the regression that the error terms are normally distributed. We therefore argue that it is still meaningful to create this estimated OLR to reflect the relationship between monetary policy target surprise and interest rate moves in 1-year-ahead 3-month Euribor futures and to capture monetary policy path surprise.

In addition, the Figure 6 also illustrates that the estimated coefficient for target surprise in the OLR is equal to 0.196, for which the signification is in the level of 10%. Concerning the constant of this linear regression, it is statistically not significant. Despite this, we still tend to keep it in the estimated OLR, with the argument that its estimated value is negligible, of -0.004.

Therefore, the estimated OLR according to the results of SPSS concerning changes in 3-month Euribor futures rates becomes as follows:

$$\widehat{\Delta ed}' = \widehat{\alpha 0}' + \widehat{\alpha 1}' * TS_t' = -0.004 + 0.196 * TS_t' \qquad (5)$$

With the use of the estimated OLR above, path surprise can be assessed as the difference between the observed and the estimated changes in 3-month Euribor futures rate on monetary policy announcement dates. An example for the computation of path surprise is showed in the previous section "FOMC announcement path surprise". Besides which, more information related to ECB announcement path surprise is also illustrated in the Appendix II.

If we look at the evolution of path surprise delivered by ECB announcements, as illustrated on the Figure 7, we observe that the period with the most fluctuation is during the U.S. financial crisis and the European sovereign crisis, which is the same for target surprise. The results of our analysis suggest that when the financial conditions are not stable and deteriorating, the ability of market participants to anticipate the monetary policy is weakened, because official monetary policy decisions-making institutions may more often take unexpected measures to safeguard financial markets.

Dependant Variable	Variables Entered	Adjusted R Square
Interest rate change in 1-year-ahead Euribor futures	ECB target surprise	0,019

	Unstandardized_Coefficients		
	β	Std. Error	Sig.
(Constant)	-0,004	0,006	0,447
ECB target surprise	0,196	0,101	0,053

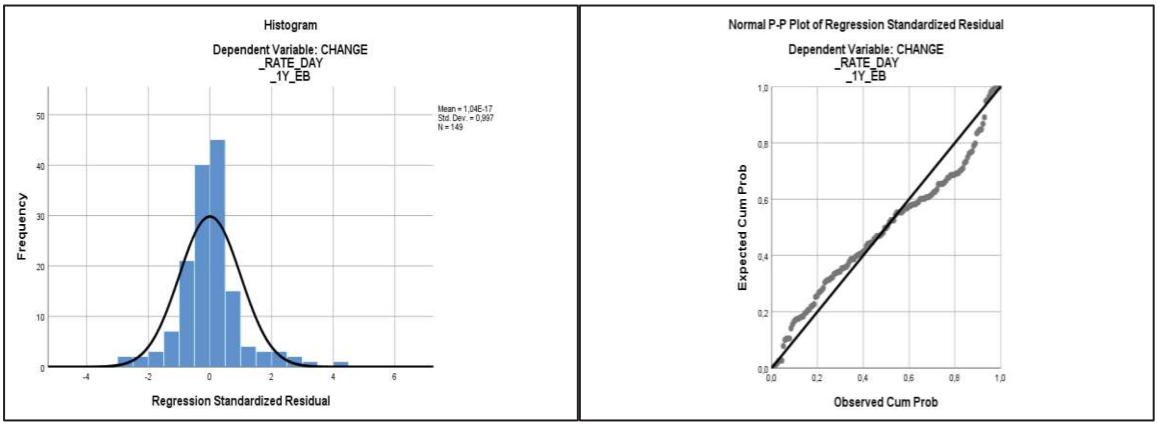


Figure 6: Regression of changes of 1-year-ahead euribor futures

Figure 7: Comparison between target surprise and path surprise (ECB)

Besides, through the comparison between the evolution of target surprise and path surprise stemming from ECB monetary policy, we can note that path surprise normally sees more fluctuation than target surprise. Especially in the post-crisis period, target surprise becomes around zero, while path surprise still remains unpredictable. This observation is supported by Pericoli and Veronese (2017) who argue in their paper that it becomes less relevant for target surprise to be considered as a source of monetary surprises due to the decrease of official rates toward zero and the adoption of quantitative easing measures after financial crisis.

5.1.4. Monetary policy announcement effects on equity markets

a) Measures of market index returns

In order to carry out an analysis related to effects of monetary policy on the Chinese markets, we take off several announcements from the monetary policy surprises samples as we mentioned in the previous section “Period of sample”. The announcements involved are those released preceding, on or following a Chinese domestic national holiday or a weekend, as well those published after other announcements in the successive days. The elimination of announcements preceding and on a Chinese national holiday or a weekend is because that they would have a too wide event window. It will be explained with further details in this section. Reasons for the exclusion of monetary policy announcements published following a Chinese domestic national holiday or a weekend or other monetary policy announcements in the successive days will be reported in the section “Heteroskedasticity Identification Approach”, beginning at the page 60.

As we decide to use the daily data to realize a statistical analysis in this paper, we apply the following equation to work out the market index daily returns:

$$R_t = \log\left(P_t / P_{t-1}\right) \qquad (6)$$

for which R_t refers to the market index daily returns, P_t and P_{t-1} represent the close price of the market index on day t and $t-1$ respectively.

As shown by the Equation (6), if the FOMC or ECB announcements are published when the markets in question are closed due to their domestic national holidays, in order to assess the market index daily returns, we will have to use the market index close prices on the first working day after these holidays divided by those on the last working day before these holidays for the log value. Consequently, the event window in this case will become as wide as several days, during which other events unrelated to FOMC and ECB announcements could happen and influence the evolution of the markets in question as well. For example, other announcements of the U.S. or the EA government decisions or the release of an international business giants earning announcements or earning warns. As a result, it could distort our analysis. Therefore, in order to obtain a purer effect of FOMC and ECB announcements on Chinese markets, we keep an event window strictly of one day by dropping all the announcements communicated to the public on the Chinese national holidays.

As we know, FOMC regularly announces their decisions to the public immediately following each scheduled meeting, as well as some unscheduled meetings and conference calls. According to Lucca & Moench (2015), FOMC published their announcements around 14:15 Eastern Time from September 1994 to March 2011. Then the time to release FOMC meeting decisions varies between 12:30 and 14:00 Eastern Time after April 2011.

However, the trading hours of the two Chinese mainland markets (SSE and SZSE) are between 9:30 and 11:30 in the morning and between 13:00 and 15:00 in the afternoon. Meanwhile, SEHK market opens from 10:00 to 16:00 with a break of 2 hours at 12:30. Due to the existence of time differences between China (including Hong Kong) and U.S. (See Figure 8), when the FOMC publishes their monetary policy decisions in the press on day t as we have explained above, it will be at least 00:30 (Daylight Saving Time) or 1:30 (Standard Time) and at most 2:15 (Daylight Saving Time) or 3:15 (Standard Time) in the early morning on day t+1 for Chinese markets (including SEHK). All of three Chinese markets are not yet open in this moment.

The same problems will have to be solved when we deal with the effects of ECB announcements on Chinese markets. ECB (2017) explains on its official website that their monetary policy decisions are communicated with the public in the afternoon, at the time 13:45 CET on the day when there is a GC monetary policy meeting. Compared to the releasing timing of FOMC announcements, the time to announce the monetary policy statement in the EA is more regular and precise. However, as showed by the Figure 8, there is still a time difference between the EA and China (including Hong Kong).

When ECB releases their announcements on day t, the time 13:45 CET will correspond to 19:45 (Daylight Saving Time) or 20:45 (Standard Time) of Chinese markets' Peking time in the same calendar day. However, Chinese mainland stock markets (SSE, SZSE) allow to trade until 15:00 (Peking time) and HESK closes one hour later than two Chinese mainland markets. In consequence, the three Chinese markets (SSE, SZSE, SEHK) have already stopped trading when ECB announcements are communicated to the public. Therefore, the possible impact of ECB announcements will not be reflected until the opening of the Chinese stock markets in the next day. This is a similar case as effects of FOMC announcements on Chinese markets.

Resulting from the time difference between areas, the Equation (6) of Market index daily returns to capture the effect of the announcements released by FOMC and ECB on the day t should be thus adjusted and becomes as follows:

$$R_t = \log (P_{t+1} / P_t) \qquad (7)$$

where R_t refers to the market index daily returns, P_{t+1} and P represent the close price of the market index on day $t+1$ and t respectively.

Let us take the announcement on September 20th, 2005 as an example. Since it is communicated to the public at 14:15 Eastern Time in the afternoon which corresponds to 3:15 in the morning on September 21st, 2005 in China (including Hong Kong), the three Chinese markets haven't opened. Therefore, the effect of the FOMC monetary policy statement will not be reflected on the Chinese markets until their open on September 21st, 2005 (Peking time) instead of in the same calendar day of the FOMC meeting, namely on September 20th, 2005 (Peking time). Moreover, as we prefer close prices which are more available in the markets to realize our analysis, this effect could be measured by market index daily returns computed with close prices on September 20th, 2005 and on September 21st, 2005. Assuming that the prices of Mainland China market CSI index for September 19th, 2005, September 20th, 2005 and September 21st, 2005 are respectively ¥ 971.14, ¥ 961.92 and ¥ 944.41, the computation should be as demonstrated below:

Market index daily returns (R_t):
= log (close price on September 21st, 2005 (P_{t+1}) / close price on September 20th, 2005 (P_t))
= log (944.41 / 961.92)
= - 0.007978

	Time Zone (Daylight Saving Time)	Time Zone (Standard Time)
U.S. (Eastern Time) *China (Including Hong Kong)*	GMT -4 GMT +8	GMT -5 GMT +8
Time Difference	**12 hours**	**13 hours**
EA (CET) *China (Including Hong Kong)*	GMT +2 GMT +8	GMT +1 GMT +8
Time Difference	**6 hours**	**7 hours**

Figure 8: Time difference between areas

b) Description of market indices

For the purpose of testing the monetary policy announcement effects on China (Mainland China and Hong Kong), we should have certain indices which are able to track the evolution of the whole equity markets in question. Based on the official websites of these two equity markets and several previous papers, we finally select respectively the CSI 300 Index for Mainland China and the HSI Index for Hong Kong.

(i) CSI 300 Index

CSI 300 Index is made up of 300 A-shares stocks which are listed on the SSE or the SZSE. These stocks are the most heavily traded in the markets and represent approximately 70% of total market capitalization of both markets. The CSI 300 index is published by the China Securities Index Company Ltd and it is widely perceived as an overall benchmark to track general movements of Mainland China equity markets. (Yang *et al.*, 2012). In addition, Hou & Li (2014) confirm as well in their paper that this index tracks the performance of the whole China Mainland equity market and that it can reflect the trends of the Chinese A-share market. The aim to create this index is to capture the fluctuation of the Chinese Mainland stock exchanges.

However, this index wasn't launched until April 8th, 2005 by the SSE and the SZSE jointly. That is why the period of our sample begins from the April of the year 2005 instead of the years when ECB and FOMC were set up.

(ii) HSI Index

According to Duan & Zhang (2001) and Ahn *et al*. (2001), HSI Index is a value-weighted index composed of 33 the most actively traded stocks in the SEHK. It is published by a subsidiary of Hang Seng Bank. It is commonly considered to track the performance of the SEHK, since its 33 component stocks represent about 70 percent of the total market capitalization of SEHK.

However, Kot *et al*. (2015) introduce some significant changes to the construction of the HSI in 2006. Firstly, the calculation of HSI is changed. This index will be computed with a weighted value based on each component share's free float instead of their full market capitalization. Secondly, the number of component stocks can reach maximum 50 instead of 33. And thirdly, a Chinese mainland firm is possible to be computed in the HSI Index if it is listed on the SEHK with H-shares and meets some criteria which include: 100% ordinary share capital with H-shares form and no unlisted share capital. Despite of the mentioned important changes, Kot *et* *al*. (2015) still argue in their paper that HSI Index can be widely quoted as a benchmark for the SEHK.

As the indices reflecting the performance of the markets in question have been decided, we can assess their daily close-to-close returns on the dates of the FOMC and ECB announcements included in our samples with the Equation 7 ; The related data are reported in the Appendices III, IV, V and VI.

c) Measure of monetary policy effects on Chinese markets

(i) FOMC monetary policy effects

To test whether FOMC announcements about U.S. monetary policy decisions have an influence on the Chinese stock exchanges, we have to make the null hypotheses as below:

$H_0^{1/2}$*(a): there is no effect of FOMC announcements target surprise on the Mainland China / Hong Kong stock exchange.*

$H_0^{1/2}$*(b): there is no effect of FOMC announcements path surprise on the Mainland China / Hong Kong stock exchange.*

If we can reject the first and/or the second hypotheses above with a certain level of confidence, for example, 95% or 90% as done by Wongswan (2009), Hausman & Wongswan (2011) and Pericoli and Veronese (2017), we are thus able to statistically conclude that FOMC announcements concerning U.S. monetary policy have an impact on the performance of the Mainland China and / or Hong Kong stock exchange.

In the paper of Wongswan (2009), he introduces the equation below to carry out a statistical test for the response of Asian markets to FOMC announcements:

$$R_t = c_0 + c_1\, TS_t + c_2\, PS_t + c_3\, S\&P_t^{Net} + \varepsilon_t \qquad (8)$$

where R_t represents the studied country index returns, TS_t and PS_t are respectively target surprise and path surprise of FOMC announcements, and $S\&P_t^{Net}$ is the overnight "Net of FOMC Effect Return in the S&P 500 index futures which is computed for the U.S. effects of non-FOMC news. For instance, U.S. firms' earning announcements published either before the open or after the close of the markets in question.

Wongswan (2009) argues that the third factor can statistically be significant to capture the general co-movement between the overnight index returns of Asian and U.S. markets.

Nonetheless, it should be computed with the change of S&P 500 index futures price in the overnight of the studied markets during which FOMC announcements are released by U.S., excluding which occurs in a 1-h window around FOMC announcements.

Due to the non-availability of the intraday data from the scholar version of Bloomberg and considering that results are approximative using either the intraday data or daily data, we decide to create regressions with daily data for the monetary policy effects. Consequently, we cannot consider the factor "Net of FOMC Effect Return" in this paper to examine the monetary policy effects. However, the isolation of this third factor becomes not evident with daily data. This measure is supported by a new paper of Wongswan in two years later, collaborated with his colleague Hausman. In their paper, Hausman & Wongswan (2011) also use daily data instead of intraday data to analyze the effects of FOMC announcements on the international markets. They reveal that the results of the regressions using the daily data are close to those using the intraday data. Therefore, they drop the third factor and apply the formula as follows which is introduced by Gürkaynak *et al*. (2005) and is adjusted to carry out for the analysis of the monetary policy with only two factors: target surprise and path surprise.

$$R_t = c_0 + c_1 \, TS_t + c_2 \, PS_t + \varepsilon_{i,t} \quad (9)$$

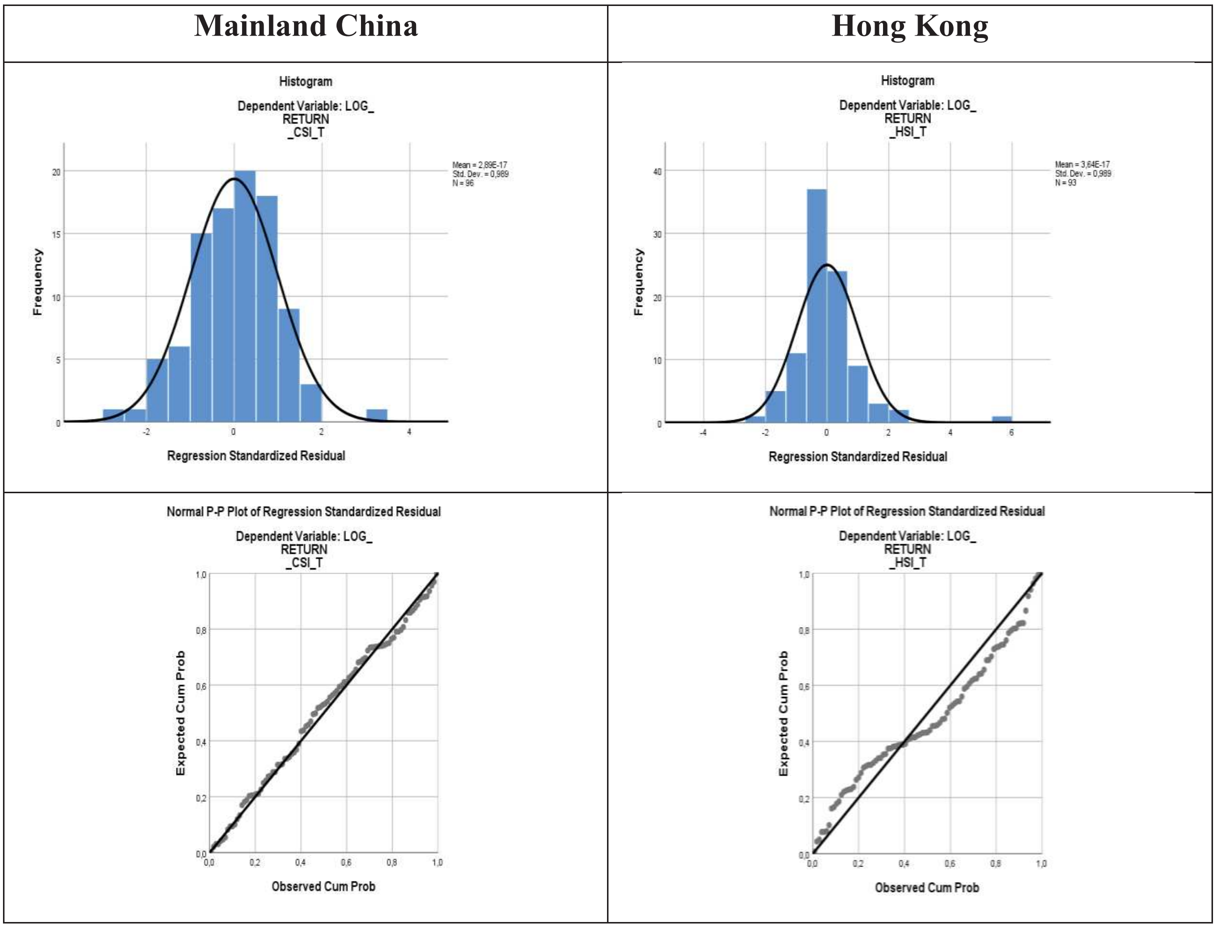
for which, $R_{i,t}$ is the index daily close-to-close log returns on date t with a computation adjusted for time difference between areas explained earlier, TS and PS are respectively the target surprise and the path surprise of FOMC announcements, and ε is the error term which would include the "Net of FOMC Effect Return" in the S&P 500 index futures ($S\&P_t^{Net}$).

To the contrary, if there is no effect from FOMC announcements on Chinese stock exchanges, both the target surprise and the path surprise of FOMC announcements will not impact the adjusted daily close-to-close log returns of CSI 300 Index and HSI Index on date t. Statistically speaking, both of our hypotheses will not be rejected, even at a significance level of 10%. Therefore, the value of c_1 and c_2 will statistically be zero with significance or will not be statistically significant to differ from zero.

Applying the data explained earlier which are reported in the Appendices III and V, with the help of SPSS, we created OLR for the reaction of Mainland China and Hong Kong stock exchanges to FOMC monetary policy shocks through taking the target surprise and the path surprise obtained in the previous sections as independent variables as what the Equation 9 requires. As a consequence, we got the results demonstrated in the Figure 9.

This figure illustrates that there would be a concern on the normal distribution of error terms of the two built OLRs, given that the histograms of regression standardized residuals do not conform a normal distribution. However, there are quasi-linear relationships between the probabilities of the theoretical and observed residuals, especially for the Mainland China stock exchanges. Besides, we also have to mention that the adjusted R square values of these estimated OLRs are only equal to 0,104 for Mainland China and 0,243 for Hong Kong. It means the created regressions do not fully explain the performance of the markets in question. This observation is consistent with the study of Bernanke & Kuttner (2005), Maćkowiak (2007) and Wongswan (2009). In their papers, it is revealed that U.S. monetary policy is not the major factor to justify the move of the evolution related to foreign equity markets. However, we only desire to evaluate the relationship between FOMC monetary policy surprises and the performance of Chinese stock exchanges. Moreover, it is already evident for independent factors in the regression to explain the dependent factor, when the R square values are between 0.1 and 0.5, according to Wongswan (2009).

If we now look at the estimated parameters of surprises for the two markets in question, they are all statistically significant in the confidence level of 90%, except the one of FOMC path.



FOMC	Adjusted R²	Constant	Signification	Target Surprise	Signification	Path Surprise	Signification
Mainland China	0,104	-0,001 *(0,001)**	0,098	-0,021 *(0,008)**	0,006	-0,018 *(0,008)**	0,03
Hong Kong	0,243	0,001 *(0,001)**	0,351	-0,055 *(0,010)**	0	-0,020 *(0,012)**	0,093

**: The coefficients standardized errors*

Figure 9: FOMC monetary policy effects (Event study)

surprise to Hong Kong stock exchanges, the other three estimated values are even statistically significant at 5% level. Thus, we should reject our null hypotheses $H_0^1(a)$ and $H_0^2(a)$ for Mainland China and Hong Kong stock exchanges respectively and conclude that statistically there is a respective effect of FOMC announcement target surprise on these two stock exchanges. Meanwhile, the null hypotheses $H_0^1(b)$ and $H_0^2(b)$ have to be rejected as well.

Statistically speaking, path surprise of FOMC announcements can also influences respectively the performance of these two markets in question. It is why we can come to the conclusion that FOMC announcements will impact the daily returns of not only Mainland China but also Hong Kong stock exchanges.

However, the negative estimated values of parameters mean that there will be a reverse influence of FOMC announcement surprises on the performance of the two stock exchanges in this paper. In other words, a positive FOMC announcement target and/or path surprise will decrease the value of CSI 300 Index and also HSI Index, while a negative FOMC announcement target and/or path surprise in contrary can raise the index values. Especially when FOMC decides an unanticipated increase (decrease) of target fed funds rate by 1%, Mainland China and Hong Kong stock exchanges would meet a loss (gain) of 0,021% and 0,055% respectively, with an error margin of 10%. Meanwhile, when the FOMC publishes information to change the expectation of market participants for the future evolution of fed funds rate, for example, instead of the prediction to maintain the rate in the future, investors now expect an increase (decrease) of future fed funds rate of 1% due to the released FOMC announcements, Mainland China and Hong Kong stock exchanges will as a result have a respective loss (gain) of 0,018% and 0,020%.

If we compare the estimated coefficients of target surprise to those of path surprise discussed above, we find that target surprise always has a larger effect than path surprise on the markets in question. This corresponds with the observation of Gürkaynak *et al*. (2005), Wongswan (2009) and Hausman & Wongswan (2011) who argue that path factor has a smaller negative impact on stock prices than the target factor when studying FOMC monetary policy effects on domestic and global equity markets.

Furthermore, to a certain extent, we will find out that FOMC announcement shocks have more effects on the performance of the Hong Kong stock exchanges than that of the Mainland China stock exchanges. Firstly, the adjusted R square value of the built linear regression for the reaction of Hong Kong stock exchanges is larger than that of Mainland China stock exchanges. It is thus assumable that FOMC target and path surprises can better explain the performance of the Hong Kong market than what they do for the Mainland China market. Secondly, the absolute values of the estimated parameters for FOMC target and path surprises in the created linear regression concerning the reaction of Hong Kong stock exchanges are both more important than those in respect of the reaction of Mainland China stock exchanges. In other words, for a certain level of target and/or path surprises delivered by FOMC monetary policy announcements, participants of the Hong Kong stock exchanges react more than those of the Mainland China stock exchanges. These reactions should normally be in the opposite direction.

(ii) ECB monetary policy effects

As introduced in the beginning, we desire to analyse the effects of ECB monetary policy as well and compare them with those of FOMC. Therefore, so as to keep the comparability of obtained effects, we worked out an analysis in "event study" based on the target surprise and path surprise as well for ECB monetary policy.

In order to test whether ECB announcements have effects on Chinese equity markets, four new hypotheses below have to be examined by an implementation of creation of linear regressions via SPSS.

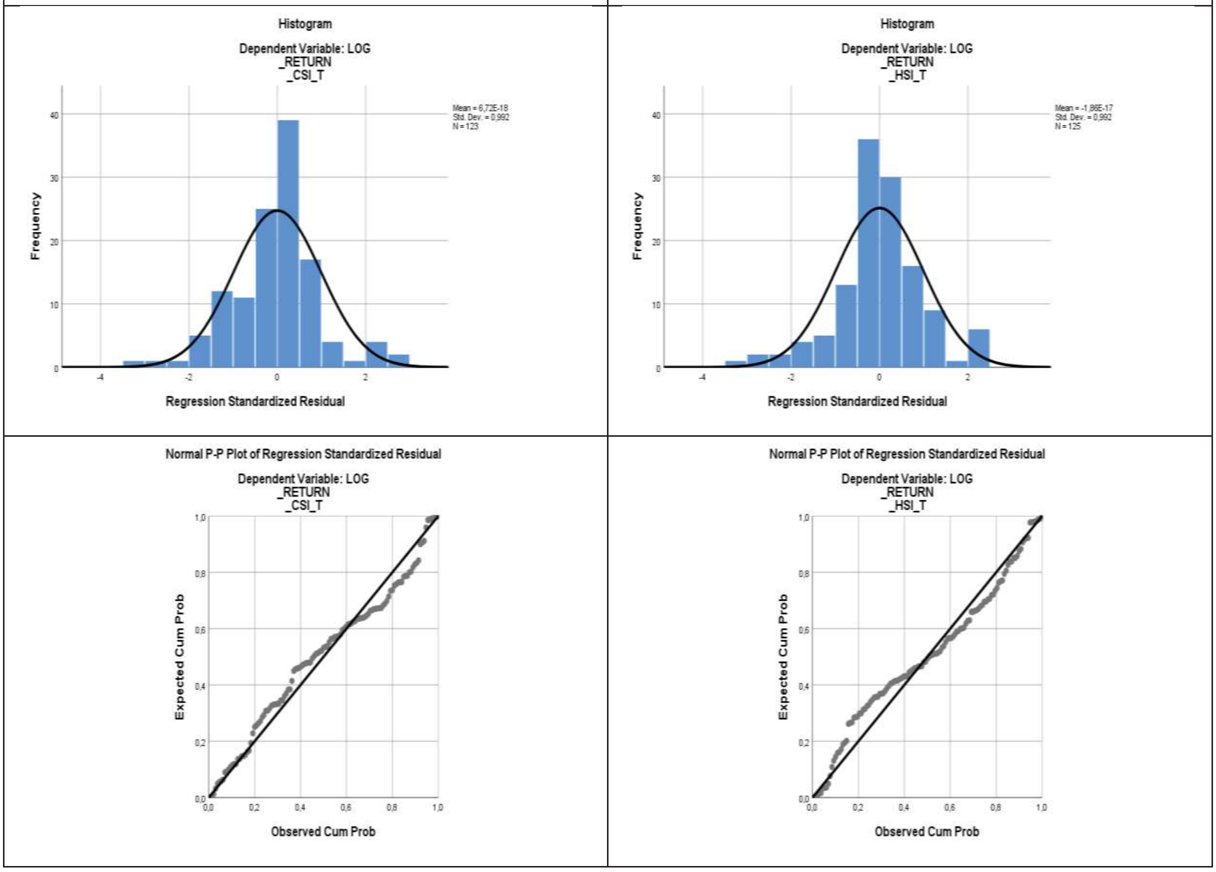
$H_0^{3/4}$(a): there is no effect of ECB announcements target surprise on the China Mainland / Hong Kong stock exchange.

$H_0^{3/4}$(b): there is no effect of ECB announcements path surprise on the China Mainland / Hong Kong stock exchange.

CSI 300 Index or HSI Index plays a role as dependent variables in these linear regressions, meanwhile ECB monetary policy target surprise and path surprise take places of independent variables. The data applied for these implementations are either quoted from the Bloomberg or treated in the previous sections. They can be consulted in the Appendices IV and VI.

The following Figure 10 illustrates that the P-P plots of the theoretical probabilities of the normal distribution versus the observed sample probabilities are approximatively linear. However, the distributions of regression standardized residuals in the histograms for the created OLRs would be a concern in terms of normal distribution.

Mainland China	Hong Kong



ECB	Adjusted R^2	Constant	Signification	Target Surprise	Signification	Path Surprise	Signification
Mainland China	0,024	0,000013 *(0,001)**	0,983	-0,019 *(0,013)**	0,134	0,015 *(0,008)**	0,088
Hong Kong	0,014	0,000 *(0,001)**	0,596	-0,006 *(0,012)**	0,63	0,015 *(0,008)**	0,067

*: *The coefficients standardized errors*

Figure 10: ECB monetary policy effects (Event study)

Nonetheless, different from the observation of FOMC effects, the adjusted R square values of built linear regressions, equalling to 0,024 and 0,014 respectively for Mainland China and Hong Kong stock exchanges, become negligible. They have even not yet reached 0.1, the minimum level that proves the evidence of the estimated regression to explain the dependant variable, revealed by Wongswan (2009). ECB monetary policy surprises therefore have little effect on the performance of the Chinese stock exchanges. However, it is still reasonable to carry out the estimations on these linear regressions, seeing that we only desire to work out the relationship between ECB monetary policy surprises and the performance of the markets in question.

Regarding the estimated value for the coefficients of target surprise and path surprise, only those of the latter are statistically significant in the level of 10%. For which reason, we cannot reject the null hypotheses of $H_0^3(a)$ and $H_0^4(a)$ for the no effect of ECB target surprise on respectively Mainland China and Hong Kong stock exchanges. That is to say it is not allowed to affirm effects of ECB announcement target surprise on both markets with a confidence of 90%. On the contrary, due to the statistical significance of the estimated coefficients of path surprise in the created linear regressions, the null hypotheses of $H_0^3(b)$ and $H_0^4(b)$ have to be rejected. Statistically speaking, path surprise related to ECB announcements has a significant effect on the markets in question with a confident level of 90%. In practice, given that the estimated values for the coefficients of path surprise in the linear regressions are both equivalent to 0,015, we could imagine a general gain (loss) of 0,015% in Mainland China and Hong Kong stock exchanges because of the change of market participants' anticipation for future interest rate evolution by 1% due to the release of ECB announcements.

In conclusion, ECB announcement surprises poorly explain the performance of the Chinese stock exchanges due to negligible adjusted R square values. This is also supported by the non-significance of the estimated coefficients of target surprise in the related two linear regressions for the confident level of 90%. Nonetheless, we are still able to conclude that there is an effect of ECB announcements on both stock exchanges, because estimated coefficients of path surprise are both statistically significant in the level of confidence 90%. In other words, effects of ECB announcements will probably be transmitted to Mainland China and Hong Kong only when there is a change of participants' expectation concerning the evolution of future interest rate in the euro zone. Moreover, these effects will be identical for respectively Mainland China and Hong Kong stock exchanges, given that the estimated coefficients of path surprise are both equal to 0,015 for these two markets.

(iii) Comparison of effects between FOMC and ECB announcements

Rogers *et al.* (2014) reveal in their paper that the transmission of monetary policy effects are mainly from U.S. to non-U.S. area. The conclusions of our paper will respect this argument, if we compare effects of FOMC and ECB announcements on respectively Mainland China and Hong Kong stock exchanges illustrated in the Figure 11. As we can see from this figure, the estimated values out of SPSS for FOMC announcement surprises are always more important than those for ECB announcement surprises. From the prospect of the adjusted R square value, the former can better explain the performance of two stock exchanges in question. From the prospect of the estimated coefficients of two surprises, target and path surprises caused by FOMC announcements have statistically more effects on Mainland China and Hong Kong equity markets than those delivered by ECB announcements. Especially concerning effects of ECB announcement target surprise, they are even not statistically significant at the level of confidence 90%.

Mainland China	**Adjusted R²**	**Constant**	**Signification**	**Target Surprise**	**Signification**	**Path Surprise**	**Signification**
FOMC	0,104	-0,001 *(0,001)**	0,098	-0,021 *(0,008)**	0,006	-0,018 *(0,008)**	0,03
ECB	0,024	1,299E-05 *(0,001)**	0,983	-0,019 *(0,013)**	0,134	0,015 *(0,008)**	0,088
Hong Kong	**Adjusted R²**	**Constant**	**Signification**	**Target Surprise**	**Signification**	**Path Surprise**	**Signification**
FOMC	0,243	0,001 *(0,001)**	0,351	-0,055 *(0,010)**	0	-0,02 *(0,012)**	0,093
ECB	0,014	0 *(0,001)**	0,596	-0,006 *(0,012)**	0,63	0,015 *(0,008)**	0,067

**: The coefficients standardized errors*

Figure 11: Comparison between FOMC and ECB monetary policy effects (Event study)

(iv) Comparison of effects suffered by Mainland China and Hong Kong stock exchanges

In the previous parts concerning the analysis of FOMC and ECB announcement effects, we have already made a comparison of effects experienced by Mainland China and Hong Kong stock exchanges. However, we still would like to make a brief summary about this in order to make the observation clearer.

From the point of view of FOMC announcements, we are able to observe that the performance of Hong Kong stock exchanges could be statistically more impacted by FOMC monetary policy surprises, consulting the Figure 9. Its performance is better explained by the linear regression created with two factors of FOMC announcements as independent variables resulted from a larger adjusted R square value. All the estimated coefficients of monetary policy surprises in the linear regressions for the reaction of Mainland China and Hong Kong stock exchanges are statistically significant in the confident level of 90%. However, the absolute values of estimated coefficients for Hong Kong are both more important than those for Mainland China.

Statistically speaking, Hong Kong stock exchanges will react more to FOMC announcement shocks including target and path surprises than Mainland China stock exchanges.

From the point of view of ECB announcements, the adjusted R square values of both Chinese stock exchanges are negligible so that the explanations of the built linear regressions to the performance of the markets in question could even be omitted. Despite this, the estimated coefficients of path surprise are both statistically significant in the level of confidence 90% for Mainland China and Hong Kong stock exchanges. Moreover, their estimated values are both equivalent to 0,015. As a result, we could say that effects of ECB monetary policy announcements on the two markets in question may be close. The relevant SPSS results are illustrated in the Figure 10.

In conclusion, Hong Kong stock exchanges experiences more impacts from FOMC monetary policy announcements than Mainland China stock exchanges, while its performance will be influenced by the ECB monetary policy announcements in the same way as that of the latter. Therefore, the released monetary policy announcements from outside will have a larger influence on Hong Kong stock exchanges than Mainland China stock exchanges.

5.2. Heteroskedasticity identification approach

We have used the event study approach which creates a linear regression to analyse effects of monetary policy on equity markets in the previous part. Nonetheless, it is questionable, since our sample period covers the financial crisis and the euro debt crisis and that the monetary policies to study in this paper include not only conventional but also unconventional monetary policies. Wright (2012) points out that no more surprises in the target federal funds rate were delivered after the financial crisis, since the interest rate is kept near zero lower bound for a long time. In addition, FOMC statements did little to alter participants' expectation about monetary policy. They instead contained lots of unconventional monetary policies to response to the deep recession, which do not work directly on interest rate. Turning to the Eurozone, the similar challenges to the event study approach resulted from target surprise and unconventional monetary policies after the euro debt crisis are also observed by Rogers *et al.* (2014), Kucharčuková *et al*. (2016) and Pericoli and Veronese (2017).

Meanwhile, Rigobon & Sack (2004) suggest that we will achieve estimates containing biases if we employ the event study approach for the monetary policy effects. In their opinion, first of all, there are interactions between asset prices and monetary policy, resulting in an endogeneity problem. Not only might a reaction of asset prices to monetary policy shocks exist, a relationship we attempt to prove and estimate in this paper, but also a response of monetary policy to movements in equity price indexes could be observed. The latter is argued in the paper of Rigobon & Sack (2003). Secondly, other variables which probably influence both asset prices and interest rates will complicate the capture of effects of monetary policy on asset markets via the previous approach, for instance, news related to the economic outlook. Moreover, the event study approach demands that the monetary policy shock should dominate all other shocks on the performance of equity markets, because the formulas created under this approach are mainly composed of target and path surprises with the ignorance of other variables. It is contrary to the argument of Gürkaynak *et al*. (2005) who says monetary policies only explain a small part of the move of equity markets.

In consequence, we would also like to utilise the heteroskedasticity identification approach which is introduced by Rigobon & Sack (2004) and applied by a number of recent papers to identify FOMC and ECB monetary policy effects on respectively Mainland China and Hong Kong for the robustness of the results achieved through the event study approach in this section.

5.2.1. Establishment of two sub-samples

As we have explained in the section "Previous studies", the heteroskedasticity identification approach captures the responsiveness of asset markets to monetary policies through the shift in the covariance of the interest rates and asset prices between announcement and non-announcement dates. It requires a weaker assumption compared to the event study approach, under which the relative importance of the variance of the monetary policy shocks increases on the announcement dates while other shocks in the system continue to take place however with the same intensity as on the non-announcement dates.

Therefore, in order to implement this approach, we first have to build two sub-samples respectively for announcement dates *(F)* and non-announcement dates *(˜F)*. Regarding the sub-sample *F*, it will consist of the monetary policy dates which are listed for the event study approach. Related to the sub-sample *˜F*, we prefer to take the dates preceding exactly those included in *F* so that we can maintain a similar size for these two sub-samples and minimize any effects due to changes in the variances of the shocks over time, justified by Rigobon & Sack (2004).

Because only daily data will be quoted for the estimation of monetary policy effects in this paper, the dates preceding announcement dates have to be discarded from the sub-sample $\tilde{F}$, when they are before or on domestic holidays or weekends for the markets in question. Otherwise, the window would become too large to extract purely the effects of monetary policy on those dates, which will be explained later in the following section. The related announcement dates in consequence also have to be abandoned from the sub-sample F, in order to keep the two sub-samples the same size. This explains the selection of announcement dates for the event study approach as well, since we would like to maintain the comparability between these two approaches. The selected dates in two sub-samples can finally be consulted in the Appendices VII and VIII for FOMC and ECB monetary policy announcements respectively.

5.2.2. Variances and covariances in two-subsamples

Once the dates in two-subsamples have been settled, we have to complete them with changes of interest rates and market index prices. Moreover, we also desire to compare the variances and covariances of these data in two-subsamples to investigate whether there are changes in the co-movement of interest rates and asset prices and that if variances of interest rates are relatively higher on announcement dates due to more intensive policy news hitting markets.

5.2.2.1. Measures of changes of interest rates

We have quoted 30-day Fed funds futures and 1-year ahead 3-month Eurodollar futures for the extraction of target surprise and path surprise delivered by FOMC monetary policy announcements respectively, while 30-day Eonia futures and 1-year ahead 3-month Euribor futures have been utilised to identify ECB monetary policy surprises in the event study approach. These future contracts can not only extract the expectations of participants about respectively short-term interest rates and future evolution of short-term interest rates, but also reflect monetary policies. However, in this second approach, it will be less appropriate to apply these future contracts.

Defined by Kuttner (2001), Wongswan (2009) and Hausman & Wongswan (2011), 30-day Fed funds futures rates depend on the average effective fed funds rates of a specific month. They are not based on the rate on any specific day. Therefore, the movement of interest rates derived from current 30-day Fed funds futures will be strongly influenced by surprises in the timing of policy shocks. It will be the same for 30-day Eonia futures, given that these two financial derivatives have similar characteristics. Concerning 1-year ahead 3-month Eurodollar or

Euribor future contracts, the fluctuation of their interest rates will also reflect the modification of participants' anticipation about future evolution of interest rates, besides the unexpected component of short-term interest rate move in the market.

Consequently, we desire to investigate the responsiveness of Chinese markets with interest rates acquired by respectively current 3-month Eurodollar and Euribor futures for FOMC and ECB monetary policy announcements. Rigobon & Sack (2004) explains the advantages to use these interest rates as our respectively FOMC and ECB "policy rates" in their paper. Firstly, interest rates extracted from these future contracts move only when there is a monetary policy shock. In addition, this movement is less influenced by timing surprises compared to that of 30-day Fed funds future rates mentioned above. Because 3-month Eurodollar and Euribor futures are based on market expectations concerning 3-month interest rates at the time when contracts expire, the corresponding current contracts only pick up surprises to expected interest rates over the coming three months.

As we explained in the "Event study approach" section, interest rates of 3-month Eurodollar and Euribor futures are computed from 100 minus prices of their contracts. If we take again the example of the FOMC announcement communicated on September 20th of 2005, instead of considering the close prices of the 3-month Eurodollar futures with a maturity in September of 2006, we have to take into account the close prices of the current 3-month Eurodollar future contracts expiring in September of 2005 for the implement of the heteroskedasticity identification approach. Therefore, the close prices of the 3-month Eurodollar futures with the nearest maturity held in two sub-samples are 95.83€, 95.87€ and 95.775€ respectively for the dates: September 18th, 19th and 20th of 2005. The variances of policy rates for this announcement are treated as below:

Sub-sample $\tilde{F}$ (September 19th, 2005): $(100 – 95.87) – (100 – 95.83) = - 0.04$

Sub-sample F (September 20th, 2005): $(100 – 95.775) – (100 – 95.87) = 0.095$

More computations of policy rates derived from the current 3-month Eurodollar and Euribor futures for FOMC and ECB monetary policy announcements in sub-samples F and $\tilde{F}$ are reported on the Appendices VII and VIII.

5.2.2.2. Measures of changes of market index prices

Given that CSI 300 Index and HSI Index have been utilised in the event study approach, we also apply the performance of these two indexes for respectively China mainland stock exchanges and Hong Kong stock exchanges in this second approach. This is the main reason why if we consider the days preceding announcement dates which are before or on local holidays and weekends in the sub-sample $\tilde{F}$, the window would be too large. Once the markets in question are closed during local holidays or weekends, we have to deal with the changes of their market index prices on non-announcement days with the close daily price on days before and after the holiday. When the window becomes larger, there will be more possibilities for news unrelated to monetary policy to occur to influence the performance of markets in question.

Changes of market index prices in two sub-samples of this approach are also be computed with the Equation (9) in the event study approach. Details are showed in the Appendices III, IV, V and VI.

5.2.2.3. Comparison of variances and covariances between two-subsamples

We can draw the Figure 12 below from the data selected in two preceding steps. It reports the descriptive statistics about the sample estimates concerning variances and covariances of daily changes in policy rates and stock market index prices on respectively announcement and non-announcement dates.

		STD. DEV. OF ASSET PRICES		COV. WITH POLICY RATES	
FOMC		*~F dates*	*F dates*	*~F dates*	*F dates*
Mainland China	*Policy rate*	2,660*	7,481*	-	-
	CSI 300 Index	0,864	0,647	0,821	-1,281
Hong Kong	*Policy rate*	2,682	7,499	-	-
	HSI Index	0,692	0,976	-0,043	-3,499
ECB		*~F dates*	*F dates*	*~F dates*	*F dates*
Mainland China	*Policy rate*	1,875*	4,037*	-	-
	CSI 300 Index	0,688	0,696	0,163	-0,118
Hong Kong	*Policy rate*	1,670*	3,805*	-	-
	HSI Index	0,680	0,628	0,424	-0,420

*: Since the announcements included in the samples of Mainland China and Hong Kong are not identical arising from different domestic holidays, the variances of policy rates for FOMC and ECB are therefore varied from one to another.

The table use daily changes in 3-month Eurodollar future rates (in percentage points) and the log value of daily changes in stock market index prices (in basis points).

Figure 12: Variances and covariances on announcement and non-announcement dates

As illustrated in the above figure, there is an obvious increase in the variances of daily changes related to policy rates on announcement dates compared to non-announcement dates, for both FOMC and ECB. It confirms there is a higher variance of monetary policy shock on announcement dates which is assumed in the heteroskedasticity identification approach.

Meanwhile, if we look at the covariances of changes in policy rates and stock market index prices, we will achieve different observations between FOMC and ECB. For FOMC, the covariances on monetary policy dates are substantially raised in absolute value. Their negative values reveal an opposite relationship between U.S. monetary policies and China stock markets. However, the covariances for ECB become negative on the dates of monetary policy announcements, while they are positive on the dates preceding announcements. Changes of covariance between the ECB monetary and non-monetary dates are also negative but small. They are less significant than those for FOMC. As a result, we could suppose that both FOMC and ECB monetary policy would have opposite effects on the China’s stock markets. Particularly, effects of the former could be larger than those of the latter.

More importantly, comparing Mainland China and Hong Kong, we can see that Hong Kong stock exchanges is more sensible to monetary policies from other countries. Its covariances with the policy rates are larger than those of Mainland China on the announcement dates with regard to absolute values. In addition, its absolute values go up on policy dates compared to non-policy dates. Regarding Mainland China, the covariances of changes in policy rates and stock market index prices become negative on the policy dates, while they are positive on the non-policy dates. The change of covariances is therefore negative. Even though the absolute value of the covariance on the ECB policy dates for Mainland China is smaller than that on the ECB non-policy date, we could thus still suppose that the American and the European monetary policies have opposite effects on Mainland China as well.

At first glance through the comparison of the changes of the variances and covariances within the framework of the heteroskedasticity identification approach, we obtain the same observation as that extracted from the event study approach. The U.S. monetary policies have larger negative effects on the China stock markets than the EA monetary policies. Meanwhile, Hong Kong reacts normally stronger to these announcements than Mainland China. In order to further verify these results, we would like to implement several empirical tests through this new approach in following sections.

5.2.3. <u>Implementation of empirical tests</u>

As described in the paper of Rigobon & Sack (2004), the difference in the covariance matrixes of the variables for the announcement dates subsample *(F)* and non-announcement dates subsample *(˜F)* can be identified as follows:

$$\Delta\Omega = \Omega_F - \Omega{\sim}F = \frac{(\sigma_\varepsilon^F - \sigma_\varepsilon^{-F})}{(1-\alpha\beta)^2}\begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^2 \end{bmatrix} \qquad (10)$$

where $\Omega_F = E[[\Delta i_t\ \Delta s_t]'[\Delta i_t\ \Delta s_t] \mid t \in F]$ and $\Omega_{\tilde{}F} = E[[\Delta i_t\ \Delta s_t]'[\Delta i_t\ \Delta s_t] \mid t \in {}^{\sim F}]$, Δi_t represents the change of the short-term interest rate, Δs_t computes the change in the asset price, σ_ε is the variance of policy shocks, and α, β measure respectively effects of monetary policy shocks and asset price shocks on one another. More detailed transformations can be consulted in the "Previous studies" section, from page 21 to 31.

For the reason that we are only interested in effects of monetary policy on equity markets, just the value α in the Equation (10) above has to be estimated. In order to realise this, there are two different ways: instrumental variables (IV) and generalized method of moments (GMM).

5.2.3.1 Instrumental variables estimate

Implementing the measure of α through the first way, we need at least two elements within the difference of the estimated covariance matrixes ($\Delta\hat{\Omega}$). Let us define $\Delta\hat{\Omega}_{ij}$ as the (i, j) element of the change in the $\Delta\hat{\Omega}$. From the Equation (10), α thus can be assessed as below:

$$\hat{\alpha}_1 = \Delta\hat{\Omega}_{12} / \Delta\hat{\Omega}_{11} \qquad (11)$$

$$\hat{\alpha}_2 = \Delta\hat{\Omega}_{22} / \Delta\hat{\Omega}_{12} \qquad (12)$$

$$\hat{\alpha}_3 = (\Delta\hat{\Omega}_{22} / \Delta\hat{\Omega}_{11}) \wedge 0,5 \qquad (13)$$

Because the third estimator is equivalent to the geometric average of the two others, we will only focus on the first and the second estimators. As illustrated by the Equation (10), the first estimator is calculated with the change of the covariance of policy rates and stock prices between policy and non-policy dates divided by the change of the variance of policy rates between policy and non-policy dates, while the second is equal to the change of the variance of stock prices between policy and non-policy dates divided by the change of the covariance of policy rates and stocks prices also between policy and non-policy dates. In order to achieve these two estimators through IV technique, according to Rigobon & Sack (2004), we have to define the changes in the interest rate and the stock price in the subsample F as T_F * 1 vectors Δi_F and Δs_F, for which T_F is the number of dates in the subsample F. Similarly, we also have to define the changes in the interest rate and the stock price in the subsample $\tilde{}F$ as $T_{\sim F}$ * 1 vectors $\Delta i_{\sim F}$ and $\Delta s_{\sim F}$, for which $T_{\sim F}$ is the number of dates in the subsample $\tilde{}F$.

If we create $(T_F + T_{\sim F})$ * 1 vectors Δi and Δs combining respectively Δi_F and $\Delta i_{\sim F}$, Δs_F and $\Delta s_{\sim F}$ to contain respectively interest rate changes and stock price changes on all announcement and non-announcement dates in our samples as follows:

$$\Delta i \equiv [\Delta i'_F \, \Delta i'_{\sim F}]'$$

$$\Delta s \equiv [\Delta s'_F \, \Delta s'_{\sim F}]'$$

and build $(T_F + T_{\sim F})$ * 1 vectors w_i and w_s as below:

$$w_i \equiv [\Delta i'_F - \Delta i'_{\sim F}]'$$

$$w_s \equiv [\Delta s'_F - \Delta s'_{\sim F}]'$$

Consequently, the Equation (11) and the Equation (12) can be transformed as follows, which confirm us that the value of α can be considered as a parameter in the linear regression of the change in asset prices (Δs_t) on the change in interest rates (Δi_t) with the instruments w_i and w_s through IV estimate.

$$\hat{\alpha}_1 = (w_i'\Delta s) / (w_i'\Delta i) \qquad (14)$$

$$\hat{\alpha}_2 = (w_s'\Delta s) / (w_s'\Delta i) \qquad (15)$$

Using the software R to implement the IV estimates, we obtain the Figure 13. The relevant computing codes are reported in the Appendix IX.

U.S.	Alpha1	p-value	Alpha2	p-value	EA	Alpha 1	p-value	Alpha 2	p-value
Mainland China	-0,045 *(0,013)*	0,0007	0,157 *(0,064)*	0,0151	**Mainland China**	-0,022 *(0,022)*	0,314	-0,037 *(0,223)*	0,867
Hong Kong	-0,070 *(0,014)*	0	-0.141 *(0.034)*	0	**Hong Kong**	-0,013 *(0,021)*	0,521	0,449 *(0,870)*	0,606

Figure 13: IV estimations for the response of Chinese stock markets to the American and the European monetary policy

As the Figure 13 shows, only FOMC monetary policy announcements have statistically significant effects on the Chinese stock markets with a confident level of 90%, while surprises of ECB monetary policy decisions do not statistically result in a significant fluctuation of the performance in both Chinese stock markets. Therefore, the U.S. might be able to transmit better their monetary policy effects to the Chinese stock markets than the EA. Moreover, comparing the Mainland China and Hong Kong, it is likely that the stock market of the latter is more vulnerable to shocks stemmed from foreign monetary policy. The values of $\hat{\alpha}_1$ and $\hat{\alpha}_2$ for Hong Kong are both significant for FOMC announcements with a confident level of 90%, while for Mainland China, only $\hat{\alpha}_1$, having a smaller estimated value than that of Hong Kong, is statistically significant within this confidence interval. These observations are consistent to the results of the event study approach.

Nonetheless, we observe that the values of the first estimator are not approximative to those of the second. According to Rigobon & Sack (2004), it might reveal that the assumptions made for the heteroskedasticity identification approach in our case are not held. Since we have proved in the preceding section that policy shocks stemmed from the monetary policy announcements of the U.S. and the EA have relatively increased across the two subsamples, other shocks in the system of the Chinese financial markets might occur without maintaining a same intensity. In fact, from the Figure 12, we are able to notice that the variances of stock prices in the announcement dates are not always larger than those in the non-announcement dates. Another reason is likely that the parameters to explain the mutual relationship of interest rates and equity prices are not stable across the two subsamples. The Hansen-Sargan J test will thus be further carried out in the section of "GMM estimates" to statistically detect whether the assumptions of our heteroskedasticity identification model are maintained.

5.2.3.2 GMM estimates

Even though the implementation through the IV estimate can be easily carried out, we still prefer the second way GMM estimate to measure the value of α. The IV estimate only thinks about two elements at a time as demonstrated above. In the opposite, GMM estimate considers all the restrictions in Equation (10). It deals with the deficiency of the former approach and thus improves the efficiency of the estimator α achieved at last.

Supposing $\lambda \equiv \frac{(\sigma_\varepsilon^F - \sigma_\varepsilon^{-F})}{(1-\alpha\beta)^2}$, it will figure out the degree of heteroskedasticity present in our data. The Equation (10) is thus transformed as below:

$$\Delta\Omega = \Omega_F - \Omega{\sim}F = \lambda \begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^2 \end{bmatrix} \qquad (16)$$

As required by GMM, Rigobon & Sack (2004) define the moment conditions as follows, considering the three restrictions in Equation (16):

$$E[b_t] = 0,$$

$$b_t = vech\ ((\Delta x_t^F \Delta x'^F_t - \Delta x_t^{-F} \Delta x'^{-F}_t) - \lambda\ [1\ \alpha]'\ [1\ \alpha])$$

for which we define $\Delta x_t^F \equiv [\Delta i_t^F \Delta s_t^F]'$ and $\Delta x_t^{-F} \equiv [\Delta i_t^{-F} \Delta s_t^{-F}]'$.

Consequently, the values of α and λ can be estimated through the "*argmin*" function below which aims to find out a group of estimates to answer the best the three restrictions in Equation 16 in the same time.

$$\{\hat{\alpha}_4, \hat{\lambda}\} = \text{argmin}\ [\textstyle\sum_{t=1}^{T} b_t]'\ W_T\ [\textstyle\sum_{t=1}^{T} b_t] \qquad (17)$$

where W_T is the optimal weighting matrix equivalent to the inverse of the sample estimated covariance matrix of the moment conditions described above.

Since there are only two parameters α and λ to estimate, the implementation of GMM model in our thesis with three moment conditions are overidentified. Therefore, a standard test of the overidentifying restrictions, the Hansen-Sargan J test, has to be carried out to verify the maintaining of the assumptions requested by the heteroskedasticity identification approach, according to Martin *et al.* (2012) and Rigobon & Sack (2004). This test can be illustrated as below

$$J\text{-}test\ value = T\ [\textstyle\sum_{t=1}^{T} b_t]'\ W_T\ [\sum_{t=1}^{T} b_t] \xrightarrow{d} \chi_n^2 \qquad (18)$$

for which n is the number of overidentifying restrictions.

The overidentifying restrictions should be rejected arising from a statistically significant value of "*J-test value*". This will imply a violation of at least one of our assumptions made for the implementation of the heteroskedasticity identification approach. As mentioned in the "Previous Studies" section, we have assumed that the variance of other shocks remains unchanged while the one of the monetary policy increases on the date of FOMC announcements and also that the parameters in the equations of the relationship between interest rate and stock price across two sub-samples are stable.

The implementation of GMM can be realized in the software R as well. The computing codes in detail are demonstrated in the Appendix X. As a result, we achieve the Figure 14 to show the GMM estimators of the American and the European monetary policy effects on respectively the Mainland China and Hong Kong stock markets.

	U.S.		EA	
	Mainland China	Hong Kong	Mainland China	Hong Kong
Alpha4	-0,006 *(0,121)*	0,375 *(0,485)*	-0,022 *(0,028)*	-0,014 *(0,033)*
J-test value	4,949	3,309	0,079	0,300

Figure 14: GMM estimators for the response of Chinese stock markets to the American and the European monetary policy

Seeing from the figure above, we notice that Hong Kong stock market would act more strongly than Mainland China stock market to U.S. monetary policy announcements. It is opposite related to the responsiveness of Mainland China and Hong Kong stock markets to EA monetary policy announcements. The former seems larger than the latter. If we compare the U.S. with the EA, it is also complicated to say which one has more effects on China through the estimated value of $\hat{\alpha}_4$.

However, the estimated values of the *"J-test value*" are significant for U.S. monetary policy effects. Thus, we have to reject the related null hypotheses for the overidentification restrictions of our GMM implementation. It implies that at least one of our assumptions is not maintained. But, it is not able to exactly identify which one is violated through the Hansen-Sargan J test. As a result, the estimators that we have obtained in this approach are not reliable. On the contrary, the assumptions made for studying the EA monetary policy effects on China's stock markets through the heteroskedasticity identification approach seems to have been maintained, given that the *"J-test value*" is not significant.

5.2.3.3 Conclusion of empirical results

We have implemented two models, the event study approach and the heteroskedasticity identification approach, to measure and compare monetary policy effects of the U.S. and the EA on China's stock markets in this section. Consequently, we achieve the Figure 15 which summarizes our empirical results.

	Event Study				**Heteroskedasticity**					
U.S.	Target Surprise	Signification	Path Surprise	Signification	Alpha 1	Signification	Alpha 2	Signification	Alpha 4	J-test value
Mainland China	-0,021 *(0,008)*	0.006	-0,018 *(0,008)*	0.03	-0,045 *(0,013)*	0,0007	0,157 *(0,064)*	0,0151	-0,006 *(0,121)*	4,949
Hong Kong	-0,055 *(0,010)*	0	0,02 *(0,012)*	0.093	-0,070 *(0,014)*	0	-0.141 *(0.034)*	0	0,375 *(0,485)*	3,309
EA	Target Surprise	Signification	Path Surprise	Signification	Alpha 1	Signification	Alpha 2	Signification	Alpha 4	J-test value
Mainland China	-0,019 *(0,013)*	0.134	0,015 *(0,008)*	0.088	-0,022 *(0,022)*	0,314	-0,037 *(0,223)*	0,867	-0,022 *(0,028)*	0,079
Hong Kong	-0,006 *(0,012)*	0.63	0,015 *(0,008)*	0.067	-0,013 *(0,021)*	0,521	0,449 *(0,870)*	0,606	-0,014 *(0,033)*	0,300

Figure 15: Summary of empirical test results on the American and the European monetary policy effects

From the point of view of stock markets, we could conclude that Hong Kong is more sensitive than Mainland China to the outside monetary policy announcements, since the majority of the estimates obtained for Hong Kong are more significant than Mainland China. From the point of view of monetary policy, it is likely that more effects of U.S. monetary policy announcements can be transmitted to the China's stock markets than those of the monetary policy decisions of the EA. Estimators for U.S. monetary policy effects are mostly important and statistically significant, except that the results of the Hansen-Sargan J test imply a violation of the assumptions made for the second approach. Related to EA monetary policy effects on China's stock markets, the estimates are usually smaller than those of U.S. monetary policy effects. Moreover, the majority of them are not statistically significant with a confident level of 90%.

Even though the Hansen-Sargan J test does not reject their null hypotheses, it does not mean that they have larger effects than the U.S..

In addition, it could be also reasonable to make a comparison of monetary policy effects only through the event-study approach, when the assumptions for the heteroskedasticity identification are violated. Kontonikas *et al.* (2013) figure out that the endogeneity problem between interest rates and stock prices can be less concerned if using daily data are used within the event study framework, as we do in this paper. They argue that changes in equity prices are unlikely to influence monetary policy decisions on the same day. The estimates through the event study approach in our paper are thus not contaminated by the interactions between equity prices and monetary policy. Furthermore, Rosa (2011) argues that the event study approach should be preferred than the heteroskedasticity identification approach, even though the former seems to have a significant bias. They find that the bias of the event study approach is fairly small and that the OLR approach seems to outperform the estimates based on the heteroskedasticity in the sense of expected squared errors, no matter for small or large sample sizes. Thus, in our paper, the estimates within the event study approach might be sufficient to capture the American and the European monetary policy effects on the stock markets of both Mainland China and Hong Kong, when the estimated values implemented by the heteroskedasticity identification approach are not reliable.

As a result, we can conclude that Hong Kong stock market is more vulnerable to the monetary policy of the U.S. and the EA, as well as that U.S. monetary policy effects are more important than EA monetary policy effects on China's stock markets.

6. Comparison of monetary policy effects and justification

The propagation of monetary policy effects to the financial markets abroad happens using different channels. To the best of our knowledge, there are few papers systematically working on analysing the determinants of the international transmission of the American and/or the European monetary policy effects, such as Ehrmann & Fratzscher (2009), Wongswan (2009) and Wongswan & Hausman (2011). They focus on such studies from five dimensions: real economic integration, financial integration, industrial composition, exchange rate regime, and country riskiness. In this section, we will develop further analyses mainly based on their work to interpret and compare the achieved empirical results from the previous section. Moreover, other determinants that they have not mentioned but are likely to influence the spillover of policy effects to China will also be considered in this thesis.

6.1. Real economic integration

Wongswan (2009) and Wongswan & Hausman (2011) indicate that a country or an area might experience business cycles which are more tied to the fluctuation of the U.S., when this country or area is more linked to the U.S. in terms of the real economy. It is as well applicable for the relationship between the economy of the EU and this particular country or area. Moreover, Hussain (2011) and Chatziantoniou *et al.* (2013) highlight that the economy in the U.S. and the EA can be impacted by their published monetary policy in different ways, for example, interest rates influence net cash flows of companies through the cost of capital. Since equity prices fluctuate in line with the performance or the outlook of the economic activities, the prices of the stock exchanges of a country or an area will respond more to the American and the European monetary policy in the case when its real economy integrates more deeply to that of the U.S. and the EA.

To measure the degrees of real economic integration, we use two proxies which are quoted by Ehrmann & Fratzscher (2009), Wongswan (2009) and Wongswan & Hausman (2011). The first is the importance of the international trade of Mainland China and Hong Kong with the U.S. and the EA respectively. It can be assessed by the ratio of the total amount of their exports plus imports with the U.S. and the EA to their GDP (Ratio 1). GDP refers to the total monetary value of all final goods and services that are produced within a country in a given period of time, according to the IMF (2017). The second is simply the ratio of their exports to respectively the U.S. and the EA to their GDP (Ratio 2), under which the influences of the U.S. and the EA economy through their demands on foreign goods and services can be captured. This second proxy is employed by Bowman *et al*. (2015) as well.

Annual international trade data of Mainland China and Hong Kong are from the Direction of Trade Statistics (DOTS) of the IMF, and annual GDP data of Mainland China and Hong Kong are derived from the World Development Indicators of the World Bank Group. Detailed data are consultable on the Appendix XI.

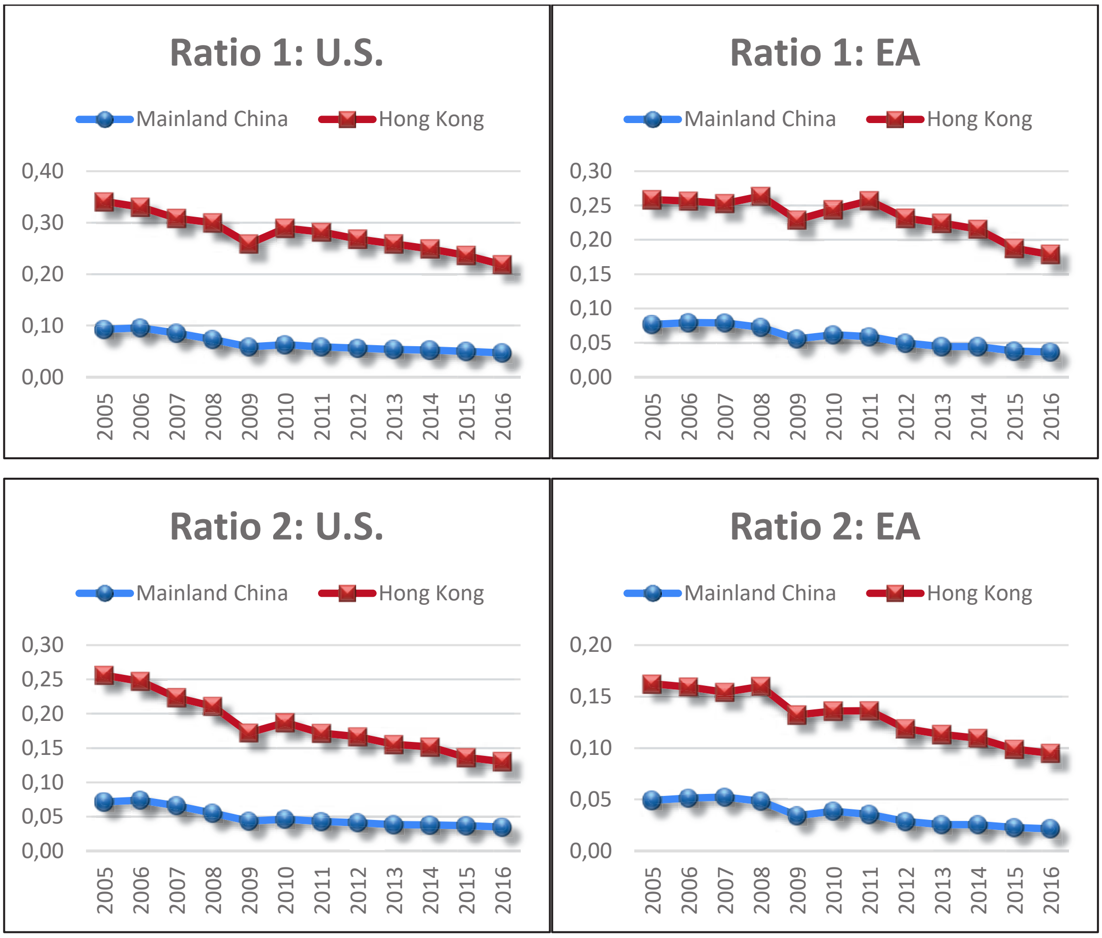


Figure 16: Comparisons of the real economic integration (between the Mainland China and Hong Kong)

As illustrated by the Figure 16 above, we can note that Hong Kong is much more linked to the real economy of the western countries than the Mainland China, no matter for the Ratio 1 or the Ratio 2. As far as we know, there will be a stronger reaction from the capital markets of a particular country or area to the released monetary policy of other countries, when they have a deeper relationship in the real economy. The stock exchanges of Hong Kong can consequently be expected to have a more important responsiveness than those of the Mainland China to the monetary policy released by the U.S. and the EA. It explains to some extent the observations which we extracted from the empirical tests in the previous sections.

If we compare the real economy integration from the point of view of the U.S. and the EA, as showed in the Figure 17, we realise that the ratios for the former are always larger than the corresponding ratios for the latter. Both Mainland China and Hong Kong are thus more integrated to the U.S. than the EA in the real economy. This finding is coherent to our empirical results, which demonstrate that the monetary policy announced by the U.S. have more effects on the Chinese financial markets than those released by the EA.

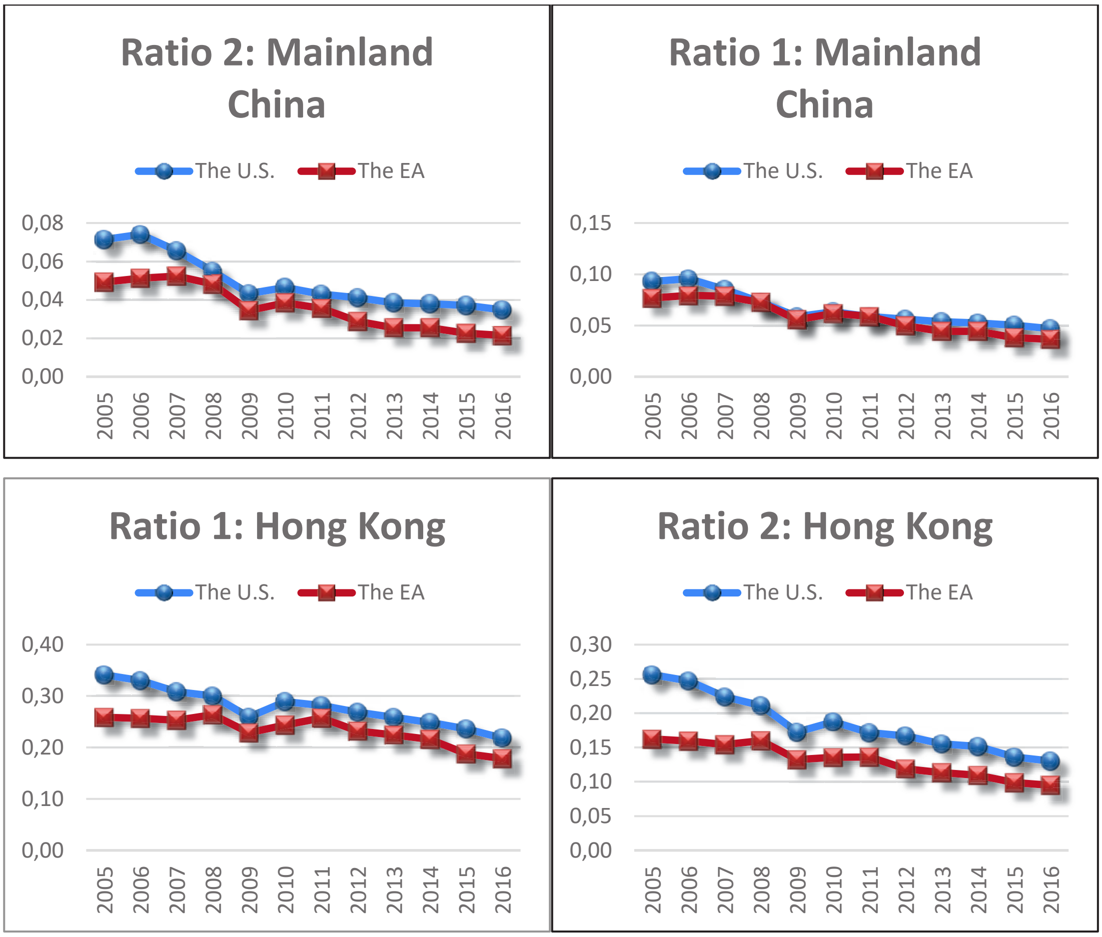


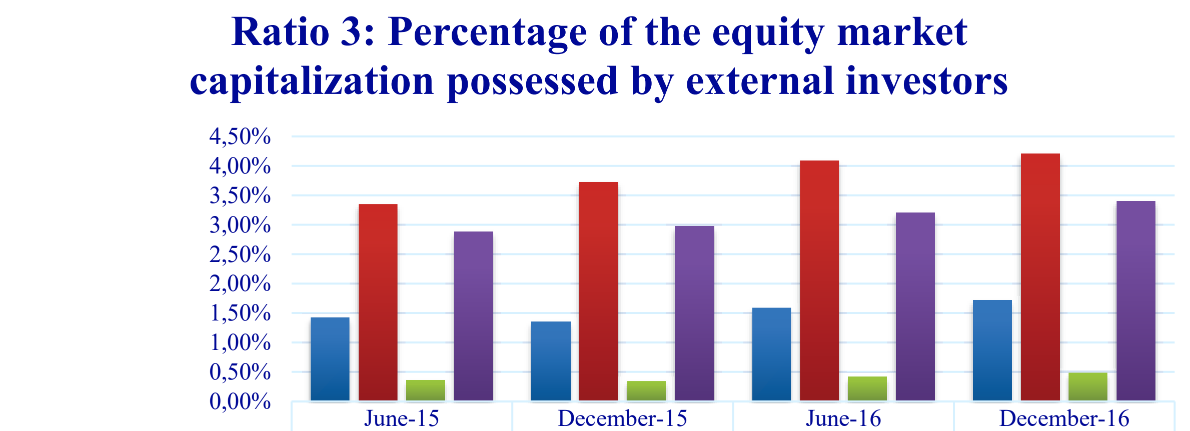
Figure 17: Comparisons of the real economic integration (between the U.S. and the EA)

6.2. Financial integration

Through empirical tests, Ehrmann & Fratzscher (2009), Wongswan (2009) and Wongswan & Hausman (2011) reveal a positive correlation between the financial integration and the global propagation of the American and the European monetary policy effects on equity markets. They figure out that the reaction of a reporting country will be stronger to the foreign monetary policy, when it is more financially integrated by this foreign country. Gali and Monacelli (2005) also justify this relationship in their paper. They argue that the monetary policy of a country can have an indirect impact on the interest rate of another country, according to the level of their financial integration. Since a surprising move of interest rate will result in an adjustment of expected future dividends and expected excess returns (for example, the equity premiums) of holding stocks, noticed by Bernanke & Kuttner (2005), the prices of stock markets of the latter country can be anticipated to fluctuate following an unexpected monetary policy released by the former country.

Wongswan (2009) and Wongswan & Hausman (2011) discover that there are no common measures for estimating the degree of financial integration, even though a number of literatures have been carried out on this subject. In this thesis, we would like to employ proxies such as: percentages of the equity market capitalization possessed by the investors from the U.S. and the EA (Ratio 3), FDI inflows as a percentage of gross fixed capital formation (GFCF) (Ratio 4) and stocks of bank lending from the U.S. and the EA in a percentage of the reporting economies' GDPs (Ratio 5).

The first proxy is utilised by Wongswan (2009) and Wongswan & Hausman (2011). It reveals the actual equities of Mainland China and Hong Kong held by respectively the American and European investors. Data concerning equity holdings of the investors from the U.S. and the euro zone are stemmed from the IMF (2018), while the equity market capitalizations of respectively Mainland China and Hong Kong are quoted from the World Bank (2018). Data of the equity market capitalizations are only available for an annual frequency. Details are reported in the Appendix XII of this thesis.



	June-15	December-15	June-16	December-16
Mainland China (U.S.)	1,43%	1,36%	1,59%	1,72%
Hong Kong (U.S.)	3,35%	3,72%	4,09%	4,21%
Mainland China (EA)	0,36%	0,35%	0,43%	0,49%
Hong Kong (EA)	2,88%	2,97%	3,20%	3,40%

The percentages of the equity market capitalization owned by the investors from the U.S. and the EA in the June of 2015 and 2016 are not accurate, because they are estimated based on the total equity market capitalizations of the Mainland China and Hong Kong in the end of the year 2015 and 2016.

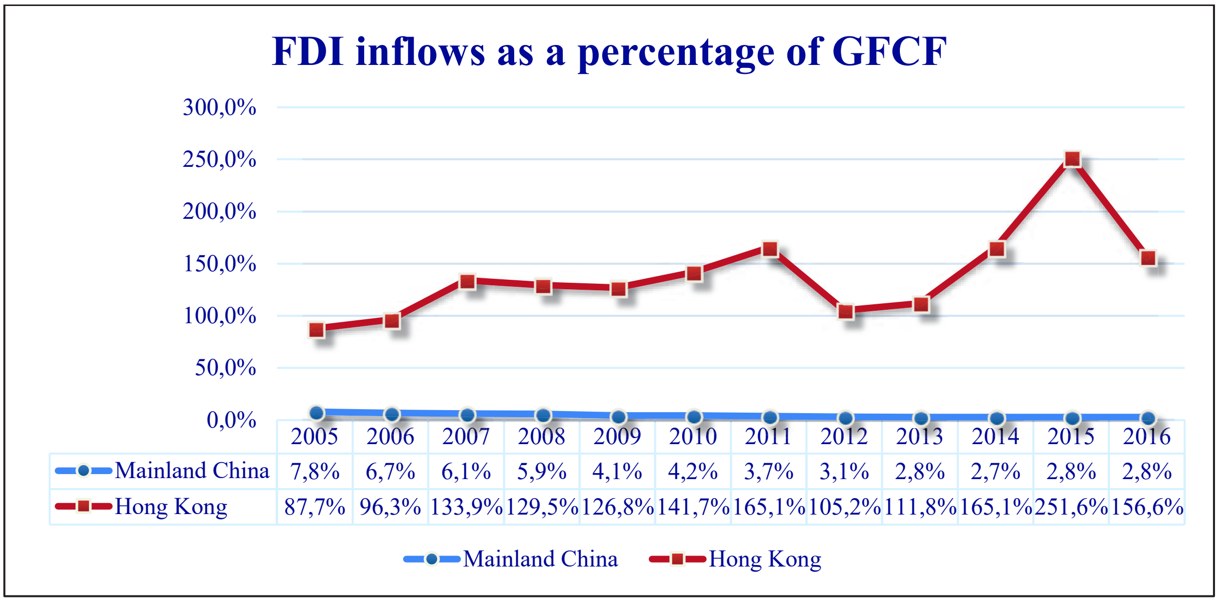
Figure 18: Equity market capitalization possessed by the investors from the U.S. and the EA (in percentage)

From the perspective of the origin of the investments, we observe from the Figure 18 that the American investors are in possession of more equities of both Mainland China and Hong Kong than those from the EA. The difference attains almost 1%. Meanwhile, from the prospective of the destination of the investments, it is obvious that a larger percentage of equities in Hong Kong markets are actually held by both the American and the EA investors. Compared to the less than 2% equities of Mainland China market, there are always more than 2,5% of the Hong Kong market's equities owed to these investors.

The second proxy, namely the Ratio 4, is based on the FDI which is introduced in the paper of Ehrmann & Fratzscher (2009) to measure the financial integration. The United Nations Conference on Trade and Development (UNCTAD, 2007) and Duce & España (2003) defines the FDI as an investment made by a resident entity of one economy aiming to obtain a long-term relationship and a lasing interest in an enterprise which resides in a different economy. It implies that the former is in possession of significant influence on the management of the latter. The Ratio 4 can thus reveal the long-term financial relationship between the reporting and the foreign economies.

In addition, according to the Organisation for Economic Co-operation and Development (OECD, 2018), the FDI inflows in the Ratio 4 refers to transactions of the net investments which foreign investors make to enterprises in the reporting economy within the measurement period. Regarding the GFCF, Financial Times (n.d.) gives its definition as the net investment of the reporting economy in total within a specific period. Therefore, the Ratio 4, which is computed as the percentage of the FDI inflows to the GFCF, can capture the importance of direct investments from the foreign economy to the reporting economy as a component of capital accounts. In our thesis, we will only apply the total FDI inflows of Mainland China and Hong Kong to their own respective GFCF, without a distinction between the FDI inflows from the U.S. and the EA, because the data detailing FDI inflows of these two reporting economies in the light of geographical origins are not available for the full sample period. The utilized data come from the UNCTAD.

As the Figure 19 shows us, Hong Kong markets depend much more on the international investors than Mainland China markets with regard to the investments in its economy. The FDI inflows from other economies to Hong Kong are even larger than what the GFCF has. In contrast, there is only an extremely small percentage of FDI inflows compared to the GFCF for Mainland China, which is always less than 10%. Since the U.S. and the EA are the two major economies which contribute to the FDI inflows of Mainland China and Hong Kong, it is reasonable to conclude that Hong Kong is more integrated by the U.S. and the EA in Finance than Mainland China.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mainland China	7,8%	6,7%	6,1%	5,9%	4,1%	4,2%	3,7%	3,1%	2,8%	2,7%	2,8%	2,8%
Hong Kong	87,7%	96,3%	133,9%	129,5%	126,8%	141,7%	165,1%	105,2%	111,8%	165,1%	251,6%	156,6%

Source: UNCTAD

Figure 19: FDI inflows as a percentage of GFCF

Concerning the Ratio 5, Ehrmann & Fratzscher (2009), Wongswan (2009) and Wongswan & Hausman (2011) figure out that it can measure the financial linkage between the economies in question and another economy through banking sector. In this thesis, the former will be Mainland China and Hong Kong, while the latter represents the U.S. and the EA. The data related to the claims by the foreign banks on the reporting economy are available on the Bank for International Settlements (BIS, 2018). It is reported in the Appendix XIII.

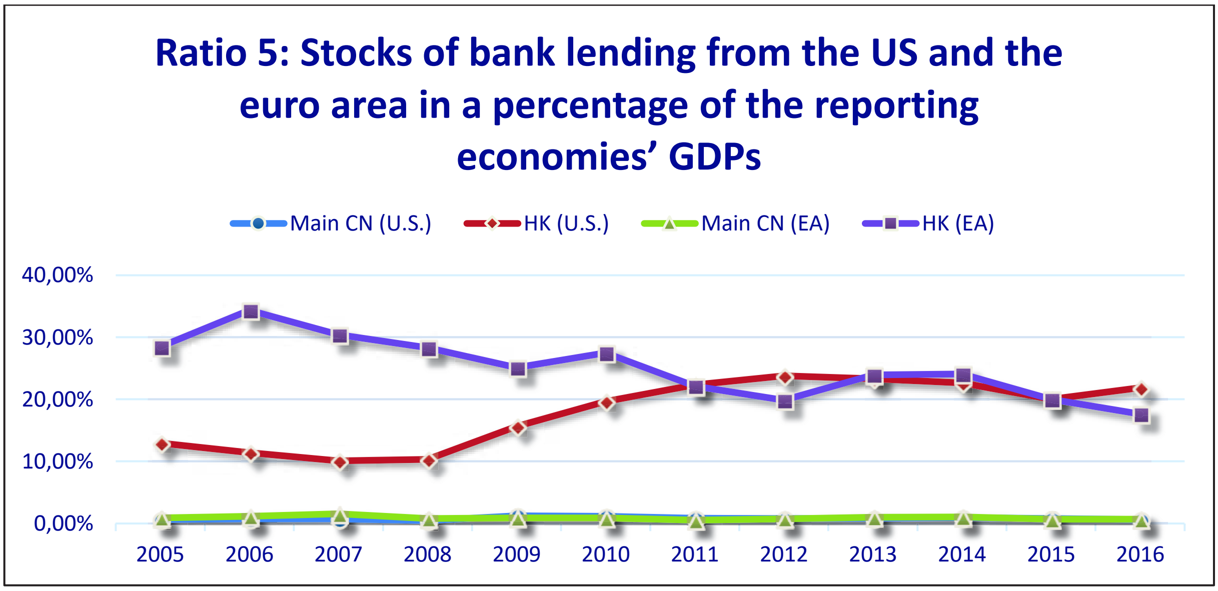


Figure 20: Stocks of bank lending from the U.S. and the EA as a percentage of GDP

It is evident that Hong Kong is more financially linked to the U.S. and the EA than Mainland China. As we can see from the Figure 20, the American and the European banks have more claims on Hong Kong. The percentages of stocks of bank lending from these two areas to GDP for Hong Kong locate within the range from 10% to 35%, while those for Mainland China lie even below 5%.

Implementing a further analysis, we would like to individually compare the financial integration of the U.S. and the EA to Mainland China and Hong Kong through banking sector. First of all, the figure illustrates a coincidental evolution of the Ratio 5 of Mainland China related to the U.S. and the EA. They have nearly equal values in the majority of the sample period. The degree of the financial linkage of the U.S. to Mainland China are thus as important as the EA. However, if we look at the evolution of the Ratio 5 for Hong Kong, it is disclosed by the figure that the EA financially integrates more than the U.S., especially before 2011. Nonetheless, the Ratio 5 of Hong Kong for the EA has a downward trend in recent years, while that for the U.S. continues to rise. As a result, we could anticipate that the American banks will be in charge of more claims on Hong Kong than the European banks, for which a deeper financial integration of the U.S. than the EA to Hong Kong through banking sector can be waited in the future.

Combining these observations of the Ratio 3, the Ratio 4 and the Ratio 5, we are able to come to the conclusion that Hong Kong is more deeply integrated by the U.S. and the EA in finance. Compared with Mainland China, more of Hong Kong markets equities are held by investors from the U.S. and the EA. A larger portion of the net investment made in Hong Kong is directly or indirectly financed by these foreign investors. Even from the point of view of the banking sector, there are more significant percentages of stocks of bank lending from the U.S. and the EA in the basis of the GDPs for Hong Kong. All the precedent observations justify one more time that Hong Kong stock markets are more sensitive than Mainland Chinese stock markets to the monetary policy surprises delivered by the U.S. and the EA.

In addition, the Ratio 3 discloses that the U.S. integrates more to the Chinese equity markets in finance than the EA, while the Ratio 5 seems to demonstrate a contradictory result. In fact, we can expect a closer financial linkage of the U.S. than the EA to the Greater China through the banking sector in the future, resulting from the upward trends of the former and the downward trends of the latter in recent years. Therefore, we are able to conclude that the U.S. possesses a deeper financial relationship to Mainland China and Hong Kong than the EA. This finding is coherent to the empirical results. It explains why the U.S. monetary policy has more effect on the Chinese equity markets than the monetary policy released by the EA, given that a higher financial integration brings a stronger reaction.

6.3. Exchange rate regime

The exchange rate regime is analysed as a determinant of the global propagation of the monetary policy effects in lots of papers, such as: Ehrmann & Fratzscher (2009), Wongswan (2009), Wongswan & Hausman (2011), Cwik and *al.* (2011), Bowman *et al*. (2015), Pericoli and Veronese (2017), and Kucharčuková *et al*. (2016). It decides how exchange rates of a country response to the fluctuation of other currencies and also the foreign exchange markets. In this thesis, it thus has effects on adjustments in the exchange rates of the Mainland China and Hong Kong as responses to changes in the policy rates of the U.S. and the EA.

In addition, we have to point out that changes in exchange rates have an impact on discount rates, because the uncovered interest rate parity (UIP), a non-arbitrage condition for international transactions, demands an equivalence of the difference in interest rates to the anticipated change in exchange rates between two economies. Moreover, changes in exchange rates can also influence expected future cash flows, since conditions of competitiveness of the goods exported to foreign countries will become different. Cwik and *al.* (2011) mention that for countries which fix their exchange rates against foreign currency, domestic output performs following the same path as the foreign output. Equity prices of Mainland China and Hong Kong might therefore be impacted by FOMC and / or ECB monetary policy announcements through their exchange rate regimes.

After carrying out a series of empirical tests, the monetarists mentioned above indicate that the responsiveness of equity markets in an economy will be smaller to the monetary policy of a foreign country, when this economy has a more flexible exchange rate regime. To identify the exchange rate regime employed in Mainland China and Hong Kong, we mainly refer to the Annual Reports on Exchange Arrangements and Exchange Restrictions (AREAER) of the IMF published in recent years.

Mainland China announced a reform to its exchange rate regime and would manage the exchange rate based on a basket of currencies instead of being pegged purely to the U.S. dollar in 2005. The currencies in the basket are composed of the U.S. dollar, the euro, the Japanese yen, the Korean won, the Singapore dollar, the pound sterling, the Malaysian ringgit, the Russian rouble, the Australian dollar, the Thai baht and the Canadian dollar (ECB, 2005, p70-

71). This new regime is classified into a managed floating exchange rate regime – “Crawl-like arrangement” by the IMF. It refers to the regime for which the exchange rate can fluctuate only within a band of 2% around the trend statistically identified through the past six months or more. According to the AREAER of the IMF, the category of the “Crawl-like arrangement” represents an exchange regime of “Soft pegs” which is a fusion of fixed and floating characteristics. Since then, the government of Mainland China has widened more and more the floating band of the renminbi’s (RMB’s) trading prices against the U.S. dollar in the interbank foreign exchange market and given greater and greater role of markets in the determination of the RMB exchange rates.

More particularly, on the July 14 of 2014, the limit of 4%, which is the exceedance of the spread between banks’ bid and offer rates of the RMB against the US dollar over the daily middle rate, was removed. Chinese banks are given the autonomy to set exchange rate quotes to their clients according to market supply and demand (IMF, 2014). Direct trading of the RMB with the euro, the pound sterling, the New Zealand dollar, the Singapore dollar, and the Kazakhstani tenge was launched in the year of 2014. The exchange rates of RMB against these currencies are determined also by the markets. It is not calculated with the reference to the cross-rates of the RMB-US dollar midrates with the exchange rates of the U.S. dollar against these currencies any more (IMF, 2015). In order to enhance the role that markets play in the determination of the exchange rate, Mainland China decided to adopt a new mechanism on the August 11, 2015 (IMF, 2016). As a result, IMF reclassified its exchange rate regime into the category of the “Other managed arrangements” in 2016.

Despite of the reform to the exchange rate regime in Mainland China, Hong Kong has maintained its “Currency board” exchange rate arrangement with the U.S. dollar. This is considered as a “Hard pegs” type by the IMF. It exchanges the HK dollar for US dollar at a fixed exchange rate. In consequence, it is able to perceive that Mainland China has more flexible exchange rate arrangements than the Hong Kong after 2005. Since previous studies have proved that the country or the area in question with a less fixed exchange rate regime will suffer more effects of the foreign monetary policy announcements on the equity markets, it is justified that Mainland China is less sensitive to the monetary policies of the U.S. and the EA than Hong Kong.

Besides which, we notice that both exchange rate regimes of the two reporting economies are also mainly based on the US dollar. The value of the HK dollar in the markets will fluctuate completely in line with that of the US dollar. Mainland China was also purely pegged to the US dollar before. It did not take into account the currency of the euro until 2005 when it added a basket of currencies beside the US dollar into the mechanism as a reference of exchange rates. The American economy is thus relatively more linked to the two reporting economies than the economy of the EA through the channel of exchange rates. There is larger global propagation of FOMC monetary policy effects which is concordant with our observation.

6.4. Openness of the economy

Gali and Monacelli (2005) and Cwik and *al.* (2011) document the openness of the economy as a key element to effects of foreign monetary policy on the domestic markets. According to the level of openness to the market, the influence of foreign monetary policy can have an indirect impact on the domestic interest rate. Ehrmann & Fratzscher (2009), Hussain (2011) and Fratzscher *et al.* (2014) further point out that foreign monetary policy announcements may lead to adjustments in equity prices of domestic markets resulted from rebalancing of portfolios across assets and countries, and especially when the economy is more open financially, capital is able to move in and out more freely. Thus, we could expect that countries with more openness will be more influenced by the foreign monetary policy. This is why Wongswan & Hausman (2011) figure out that capital controls do protect domestic markets from foreign monetary policy shocks.

To our knowledge, two different systems are applied in the economies of Mainland China and Hong Kong. With the communism policy, companies in the Mainland China were almost held by the government during the 20th century. But in need of capital, Mainland China decided to reopen stock markets and to transform state-owned enterprises (SOEs) into joint stock companies whose stock could have been publicly traded. However, only a third of them followed that decision at that time. The rest are still in the hands of the government which kept them under control and away from worldwide effects. (Chang & Jin, 2016).

We can observe through the annual reports of the CSRC that the float ratio of Mainland China, meaning the outstanding tradable shares in the percentage of the total outstanding shares, has continued to increase over time. In the annual report of 2014, it has increased to 89.67% from 51.29% in the year of 2008 (CSRC, 2014).

Metrics	2008	2009	2010	2011	2012	2013	**2014**
No. of companies listed in China (A-shares and B-shares)	1.625,00	1.718,00	2.063,00	2.342,00	2.494,00	2.489,00	**2.613,00**
No. of foreign-invested companies listed in China (B-shares)	109,00	108,00	108,00	108,00	107,00	106,00	**104,00**
No. overseas listed companies	153,00	159,00	165,00	171,00	179,00	185,00	**205,00**
Total outstanding shares (100 mn shares)	24.522,85	26.162,85	33.184,35	36.095,52	38.395,00	40.569,08	**43.610,13**
Including free float (100 mn shares)	12.578,91	19.759,53	25.642,03	28.850,26	31.339,60	36.744,16	**39.104,28**

Source: CSRC, 2014, p 83.

Figure 21: Composition of Mainland China exchange markets

According to Ma *et al*. (2013), Mainland China has only a low degree of openness. Compared with other stock markets, stocks in Mainland Chinese markets are less interactive with international stocks. On the other hand, Yeh & Lee (2000) and Ma *et al*. (2013) say that Hong Kong is the one of financial centres in the world. Applying the capitalism policy, its economy is almost fully open. Any control over either foreign transaction does not exist. Ahn *et al*. (2001) mention in their paper that Hong Kong is a market purely driven by the buy and sell orders.

Through a review of previous studies on the openness of Mainland China and Hong Kong respectively, we are able to conclude that the former is less open than the latter. In Mainland China, a significant part of shares in the market are still under the control of the government and therefore are not tradable. In contrast, markets in Hong Kong are free to be accessed by investors. In order to further identify the openness level of these two reporting economies, we work out the Figure 22, summarizing controls on transactions in our reporting economies described in the AREAER of the IMF from 2012 to 2016.

Mainland China	2012	2013	2014	2015	2016
Controls on payments for invisible transactions and current transfers	X	X	X	X	X
Capital transactions controls on:					
Capital market securities	X	X	X	X	X
Money market instruments	X	X	X	X	X
Collective investment securities	X	X	X	X	X
Derivatives and other instruments	X	X	X	X	X
Commercial credits	X				
Financial credits	X	X	X	X	X
Guarantees, sureties, and financial bankup facilities	X	X	X	X	X
Direct investments	X	X	X	X	X
Liquidation of direct investment	X	X	X	X	X
Real estate transactions	X	X	X	X	X
Personal capital transactions	X	X	X	X	X

Hong Kong	2012	2013	2014	2015	2016
Controls on payments for invisible transactions and current transfers					
Capital transactions controls on:					
Capital market securities					
Money market instruments					
Collective investment securities					
Derivatives and other instruments	X	X	X	X	X
Commercial credits					
Financial credits					
Guarantees, sureties, and financial bankup facilities					
Direct investments					
Liquidation of direct investment					
Real estate transactions			X	X	X
Personal capital transactions					

Figure 22: Summary features of controls on transactions in Mainland China and Hong Kong

As illustrated in the figure, Mainland China sets restrictions on all kinds of transactions for foreigner investors. In fact, there are two classifications in Mainland Chinese domestic markets: A-shares and B-shares. B-shares are designed for foreign investments, but they represent only a small percentage of total market capitalization. However, the major shares in the market, A-shares, are only accessible for foreign investors qualified QFII from 2002 and RQFII from 2011 (SSE, 2015). Hong Kong, however, is a laissez faire economy. There are nearly no controls on foreign transactions.

Moreover, HKEX plays the role of a conduit between Mainland China and the outside world. In order to facilitate access to financial markets to and from China, the Shanghai-Hong Kong Stock Connect Plan and the Shenzhen – Hong Kong Stock Connect Plan have been released in

November 2014 and December 2016 respectively. There is no more need of onerous QFII or RQFII licenses. But foreign investors can only have indirect access to the Mainland China A-shares thanks to their accounts created in Hong Kong stock markets. (Raine & Adams, 2015).

In conclusion, Mainland China still has a number of restrictions on foreign investments, even though it continues to facilitate access for foreign investors. Hong Kong fully opened its markets to international market participants. It even plays an intermediate role between Mainland China and the outside world. As a consequence, Hong Kong is more sensitive to outside shocks to the economy, including foreign monetary policy surprises. It is consistent with our empirical results, which show that Hong Kong responds more to the American and the European monetary policy decisions.

6.5. Industrial compositions

In the paper of Bernanke & Kuttner (2005), the reactions of stock markets to monetary policy shocks can be also explained by the industrial compositions, since levels of sensitivity to monetary policy shocks are varied across sectors. They find that a riskier industry will be more sensitive. They compare the high-tech and telecommunications sectors with the energy and utilities sectors as an example and observe that the former responses more than the latter. In this thesis, we would therefore like to justify the results of our empirical tests through a comparison of industrial compositions of Mainland China and Hong Kong as well. The statistics of sector stocks in the stock exchanges will be employed as a proxy. The relavant data come from the SZSE, the SSE and the SEHK respectively. As the statistics of sector stocks for the whole of Mainland China are not directly available, we work out the Figure 23 for the industrial compositions of Mainland China combining the SZSE and the SSE. Individually detailed information for these two stock exchanges can be consulted in the Appendix XIV.

As we underline in the figure, the manufacturing sector is weighted the most heavily in the economy of Mainland China. It represents more than 45% of the total market capitalization, while other sectors only occupying around 5% of the capital resources, except the financial sector. But with a market value equal to the 19%, financial sector is still much less important than the manufacturing sector. Turning to Hong Kong, we achieve an opposite image. The financial sector becomes the essential sector in the economy of Hong Kong, with a percentage of near 30%. Considering the risk sectors other than the financial sector, such as: the telecommunication and the information technology, we obtain in total a market value equivalent to the 48.44% of the total market capitalization.

Given that the manufacturing sector is less than the financial, telecommunications and information technology sectors, we can conclude that the economy of Mainland China is mainly composed of less risky industries than that of Hong Kong. As a result, it will be less affected by foreign monetary policy surprises compared to Hong Kong. The industrial composition, among other determinants of the global spillover of the American and the European monetary policy, explains the reasons for the different responses of Mainland China and Hong Kong observed in the previous sections.

	Mainland China stock exchanges				Hong Kong		
Industry	**Amounts**	**Market Value (100 M in RMB)**	**Percentage**	**Industry**	**Amounts**	**Market Value (100 M in HK dollar)**	**Percentage**
Agriculture	46	4538,04	0,88%	Energy	72	9916,46	4,06%
Mining	76	33548,76	6,53%	Materials	134	5047,00	2,06%
Manufacturing	2117	233945,85	**45,55%**	Industrials	210	8794,42	3,60%
Utilities	102	18373,97	3,58%	Consumer Goods	434	27443,19	11,22%
Construction	98	19075,77	3,71%	Consumer Services	196	17293,79	7,07%
Wholesale & Retail	167	17111,19	3,33%	**Telecommunications**	15	21248,93	**8,69%**
Transportation	98	17321,08	3,37%	Utilities	59	13568,18	5,55%
Hotels & Catering	13	820,19	0,16%	**Financials**	159	72297,88	**29,57%**
IT	222	25999,92	5,06%	Properties & Construction	291	34204,00	13,99%
Finance	70	97576,02	19,00%	**Information Technology**	128	24881,99	**10,18%**
Real Estate	139	22516,69	4,38%	Conglomerates	15	9808,53	4,01%
Business Support	44	6466,14	1,26%				
Research & Development	30	1732,25	0,34%				
Environmental Protection	38	4085,06	0,80%				
Education	3	245,26	0,05%				
Public Health	7	1237,11	0,24%				
Media	50	7076,56	1,38%				
Conglomerates	23	1942,90	0,38%				
Total	3343	513612,77	100,00%	Total	1713	244504,37	100,00%

Figure 23: Industrial compositions in Mainland China and Hong Kong (in December of 2016)

6.6. Summary of determinants

	In December of 2016	Mainland China	Hong Kong
Real economic integration	Ratio 1 ((Export + Import) / GDP):		
	US	0,05	0,22
	Euro area	0,04	0,18
	Ratio 2 (Export / GDP):		
	US	0,03	0,13
	Euro area	0,02	0,09
Financial integration	Ratio 3 (% of the equity market capitalization for investors from):		
	US	1,76	4,21
	Euro area	0,49	3,4
	Ratio 4 (FDI inflows / GFCF):	2,81	156,61
	Ratio 5 (% of stocks of bank lending from other countries / GDP):		
	US	0,66	21,88
	Euro area	0,7	17,63
Exchange rate regime	Categories:	Crawl-like arrangement	Currency board
	Types:	Soft pegs	Hard pegs
Openness of the economy	Government Controls:	Yes	No
Industrial compositions	Major sectors:	Manufacturing	Financial

Figure 24: Summary of determinants to global spillover of the American and the European monetary policy effects on Mainland China and Hong Kong (in December of 2016)

We know that the Hong Kong stock markets are more affected by the American and the European monetary policy shocks than Mainland Chinese ones and also that effects of U.S. monetary policy decisions will be transmitted better to Chinese stock markets than those of the EA monetary policy announcements, through implementing empirical tests. In order to justify these observations, we have already carried out several detailed analyses in previous sections. Here, we would like to summarize these analyses and make systematical explanations to maintain justifications clear.

Firstly, from the perspectives of Mainland China and Hong Kong, no matter which point of view, such as: real economic integration, the financial integration, the exchange rate regime and the openness of the economy, Hong Kong has always a closer linkage with the U.S. and the EA than Mainland China. Meanwhile, in terms of industrial compositions, Hong Kong is mainly composed of risky sectors, such as the financial sector, which leads it to being more sensitive to foreign monetary policy surprises.

Secondly, from the perspective of the U.S. and the EA, it is obvious that the U.S. is more integrated to Mainland China and Hong Kong in both the real economy and finance. Concerning the exchange rate regime, to our knowledge, it is normally related to the way a country adjusts its exchange rate against the U.S. dollar. It is applicable in the case of Mainland China and Hong Kong, especially the latter. The euro is not considered in their exchange rate regimes until Mainland China added it in the basket of currency as a reference of exchange rate arrangements in 2005. Therefore, effects of U.S. monetary policies can spread more easily to Mainland China and Hong Kong, while the international transmission of effects of ECB monetary policies are more limited.

7. Conclusion

The significant position of China among market leaders has been increasing since years. The impressive growth of its financial markets grabs more and more attention and participation from international investors, despite the protectionist policy applied in Mainland China with the implementation of government controls. Given that the U.S. and the EA are the two most important commercial and financial partners of China, should their monetary policy surprises be considered as a risk factor when making investment decisions in China? Could we build a diversified portfolio with assets in the markets of these three areas to avoid unacceptable risk? This thesis focuses on the responsiveness of Chinese financial markets to American and the European monetary policy announcement surprises respectively and further compares these international transmissions between Mainland China and Hong Kong, because of the "one country, two systems" policy in China.

To measure and compare the propagation of the U.S. and the EA monetary policy effects to Mainland China and Hong Kong, we select a total of 123 U.S. and 149 EU official announcements and important FOMC and ECB president speeches from April 2005 to May 2017 using daily data from Bloomberg. Due to the time difference between the U.S., the EA and China, these selected announcement dates should not be on the day preceding, during or after a Chinese national holiday or a weekend. The created samples include not only the conventional monetary policy, but also unconventional monetary policy, because the analyzed period covers the financial crisis in the U.S. and the debt crisis in EA.

First, we used the "event study" approach to carry out an empirical test, with the assumption that the monetary policy shock dominates all other shocks in the system. It is introduced by Bernanke & Kuttner (2005) and Gürkaynak *et al*. (2005), and then evaluated by Wongswan (2009) and Hausman & Wongswan (2011) to measure the global influence of U.S. monetary policy surprises. We create the linear regressions with two factors: target surprise and path surprise.

We find that when FOMC decides on an unexpected increase (decrease) of target fed funds rate by 1%, Mainland China and Hong Kong stock exchanges would meet a loss (gain) of 0,021% and 0,055% respectively, with a significant level of 90%. Meanwhile, if FOMC monetary policy announcements deliver a surprise 1% increase (decrease) related to the evolution of future interest rates, Mainland China and Hong Kong stock exchanges might as a result suffer

0,018% and 0,020% loss (gain), at the 90% confidence interval. We notice that the effects of U.S. monetary policy on the Chinese financial markets are in the opposite direction of the surprises. Moreover, target surprise plays a more important role than path surprise for both markets. These conclusions are in line with the findings of Wongswan (2009) and Wongswan & Hausman (2011).

Concerning the ECB monetary policy decisions, Mainland Chinese and Hong Kong stock exchanges could be exposed to a gain (loss) of 0,015% only when market participants' anticipation for future interest rate evolution is raised (dropped) by 1% due to the path surprise, for a 90% significant level. ECB monetary policy has a observable positive influence on both Chinese markets. Fratzscher *et al.* (2014) explain that ECB unconventional monetary policy announcements result in a reduction of risk aversion and credit risk in sovereign and global banks.

Second, we execute the heteroskedasticity identification approach introduced by Rigobon & Sack in 2004. With its implementation, we aim to assess robustness of the empirical results and also to deal with limitations of the first approach in measuring unconventional monetary policy surprises and omitting other variables in the market. For this approach, we only need to assume that monetary policy shocks are relatively more significant on the policy dates than the non-policy dates, which is confirmed by the increase in variances of policy rate daily changes in our two sub-samples for policy dates and non-policy dates respectively. However, since the values of Hansen-Sargan J test, which examines the maintaining of these assumptions are all significant, it implies that at least one of our assumptions is violated. Consequently, the estimates achieved are not reliable, even though those using the instrumental variables technique are consistent to the observation within the event study approach.

As Rosa (2011), Kontonikas et al. (2013), and Haitsma et al. (2016) argue that changes in equity prices are unlikely to influence monetary policy decisions on the same day. The bias of the "event study" approach is fairly small, and as well as that the OLS approach tends to outperform the estimates based on the heteroskedasticity in the sense of expected squared errors, it seems that the implementation of the "event study" approach is sufficient to capture the American and the European monetary policy effects on the stock markets of both Mainland China and Hong Kong in our paper, when the estimated values implemented by the "heteroskedasticity" approach are not reliable.

It appears from the computations and statistical analysis that both Mainland China and Hong Kong are impacted by American and European monetary policy. However, Hong Kong is more sensitive to foreign monetary policy surprises and the U.S. transmits their monetary policy effects to Chinese stock markets more than the EA does. These findings corroborate with those of Perez-Quiros & Sicilia (2002), Wongswan (2009), Wongswan & Hausman (2011) and Rogers *et al.* (2014).

In order to understand and justify the observations above, we carried out a further systematical analysis from five determinants to the international transmission of monetary policy effects: real economic integration, financial integration, exchange rate regime, openness of the economy and the industrial composition. We observe that Hong Kong is more integrated in real economy and finance with the U.S. and the EA. Its exchange rate regime is purely pegged to the US dollar. While its economy is fully open to the world, it is mainly composed of risky industries due to the largest percentage of total market capitalization being the financial sector. Hong Kong therefore has a closer relationship with the U.S. and the EA than Mainland China, which make it more vulnerable to the monetary policy of these two areas.

Meanwhile, comparing the U.S. with the EA, it can be noted that the U.S. is more integrated to the real economy and the finance of China. Furthermore, the US dollar plays a significant role in the determination of exchange rates. It can thus be expected that there is a larger transmission of U.S. monetary policy effects through the channel of exchange rate arrangements.

Overall, considering the significant propagation of U.S. monetary policy effects to the Mainland Chinese and Hong Kong stock exchanges, this thesis suggests that U.S. monetary policy surprises could be considered as a risk factor to the investments in Chinese financial markets. Nonetheless, a diversified portfolio could be built, composed of assets in Mainland China and the EA to minimize risks. Besides, external shocks caused by external monetary policy could be prevented if the Hong Kong government applies measures relating to exchange rate regime and the industrial compositions. Keeping a highly integrated real economy and finance sector with other economies and maintaining the openness of its economy are the keys ways to encourage a continuing development.

Although we have made a global analysis of the relationship between Chinese markets and two of the largest economies in the world through monetary policy, we should still highlight the limitations of our paper. First of all, our event windows might be too large to capture pure monetary policy surprises. Because we have no access to intraday data, we used daily data during which several shocks unrelated to monetary policy decisions could also be captured by the event study approach. Another limit could be the size of our samples. Choosing a larger sample could help us to understand if effects of unconventional monetary policy are still significant on a longer period and whether the Hong Kong Stock Connect Plan launched in 2014 can have an influence on our empirical results. Finally, it could be also interesting to study those effects on more economies in order to make a comparison of their global spillover. Moreover, we could also carry out empirical tests on the five determinants through a wider sample, in order to identify their respective roles on determining the international transmission of American and European monetary policy effects.

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