The Fed and the Rest: International Spillover Effects of U.S Monetary Policy Announcements.

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Abstract

This research investigates, at first, whether the monetary policy (conventional or unconventional) shocks in the United States have significant effects on the financial asset price (equity prices, bond yields, and exchange rates) in the rest of the world, then evaluate to what extent the response of foreign asset prices to US monetary surprises vary across advanced and non-advanced countries and how these reactions changed in conventional (1996-2008) and unconventional monetary policy times (2008 - 2017). Overall, we find that the international spill overs from US monetary policy shocks are substantial; moreover, it shows that in many countries the effects of spill overs on the markets are higher than the domestic impact in the US itself.

Moreover, the study compares the domestic reactions to the international reactions and concluded that the magnitudes of the reactions of the international financial asset price to US monetary policy surprises are different relative to the domestic reactions. For instance, the responses of international fixed income market prices are lower than the domestic responses while the foreign stock market is more responsive. Therefore, it is not easy to say whether the Fed has more effect on the international market or the other way around but it depends on the markets. It further examines whether there are differences between the response of international financial assets before and after quantitative easing to the monetary policy surprise in the US and found that the response of international exchange rates to US monetary shocks increase about eight times after the quantitative easing. Similarly, we documents that advance and non-advanced countries respond to US monetary policy differently. For example, the response of advanced countries exchange rates to the US monetary policy surprises increased about 7 times while non-advanced countries vulnerability increased 9 times after the quantitative easing. These results led to the interpretation that the US dollar has increased its domination of the world currency markets after quantitative easing which caused a four times increase in the amount of dollar (the Fed balance) in international markets.

Keywords: Central Bank Communication, Financial Spilovers, Monetary Policy Shocks
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1 Introduction

U.S. monetary policy has always had an important role not only for US markets but also for other foreign financial markets. Rajan (2015), the former governor of Indian central bank, pointed out that as a response to the recent financial crisis, expansionary monetary policy interventions in advanced economies triggered global adverse effects on real and financial stability for the rest of the world. To mitigate these impacts, he suggested the need for international monetary policy coordination. In particular, Rajan (2015) argued that the Fed should take the rest of the world into account while making a monetary policy for the sake of international financial stability since the vulnerability of world economy as a result of the Fed policy has increased. Similarly, Georgiadis (2016) argued that the spillover effects of Fed monetary policy and its negative impact on the achievement of the domestic task in developing countries have increased considerably.

As an example, following the FOMC meeting on September 18, 2013, for example, the Fed surprised financial markets substantially. Of significant note is that the Fed did not begin to taper its quantitative easing programme, meaning that bond and mortgage-backed securities purchases remained the same, nor did it change the interest rate and therefore, fed funds target rate unchanged at a range of zero to 0.25 percent. However, U.S. 10-Year Treasury bonds decreased almost 20 bps within hours following the release of the statement, whereas stock index increased - S&P500 soared by 1.2 percent. In parallel, Rajan (2015) points out that the effects of this policy announcement were not limited merely to the domestic (the US) market; rather it also had an international spillover effects. The value of the dollar decrease just a couple of hours after the announcement on September 18, 2013 falling over 1% against Japanese Yen and the Euro, and more than 2% against emerging market currencies. As an individual case, amongst others, the Brazilian stock market increased two percent on the same day which is a greater reaction than the S&P 500. Converse movements were observed in May 2013 with the FOMC announcement, when sovereign yields in most of the world economies increased considerably and the value of dollar appreciated.

In this respect, this study investigates the sensitivity of world economies to the Fed monetary policy. In simple terms, this chapter asks two main questions, the first, whether the monetary policy shocks (conventional or unconventional) in the US have significant impact on the financial asset price (equity prices, bond yields, and exchange rates) in the rest of the world. Secondly, if so, does the response of foreign asset prices to US monetary surprises vary across advanced and non-advanced countries? If yes, does the response have a different pattern during conventional (2000-2008) and unconventional monetary policy times (2008-2017)?

These questions are crucial on several grounds. Firstly, from an asset pricing aspect, examining global markets' response will help recognise whether US monetary policy influences a more diverse set of assets. If US monetary policy affects international financial assets significantly, this adds weight to the opinion that US monetary policy may be a risk factor in international financial markets. Secondly, the relationship between monetary policy in the US and global financial asset prices is the most direct and immediate way of measuring the effects of US monetary policy on international economies. Finally, since monetary policy has effects on the real economy through financial markets, it is essential that both US and global policymakers and financial agents have quantitative estimates of the connection between monetary policy and international asset prices.

This research contributes to different strands of the literature on the spillover effects of monetary policy. In particular, the first potential contribution is that this research does not focus solely on advanced or emerging markets in contrast to most papers in the literature. To the best of our knowledge, this is the first paper to investigate the reactions of international asset prices to FOMC policy announcements using daily dataset that covers both advanced and non-advanced countries by considering conventional and unconventional times in terms of monetary policy in the US. The dataset herein is the largest possible that attempts to investigate the impact of U.S. conventional and unconventional monetary policy on international financial markets, which are exchange rates, bond yields, and stock prices in a total of 56 countries (advanced and non-advanced) for the period from January 1996 to November 2017.

By using the event study method, it is shown that international assets markets are sensitive to any change in US monetary policy both before and after recent economic crisis. Furthermore, different assets respond to various components of monetary policy surprise. Fed policy surprises mainly affect exchange rates and international bond markets. Moreover, as the Fed used different tools during, before and after the crisis, the impact of these tools may have been different on foreign asset prices at these different times. This study finds that the responses of asset prices appear to be different in conventional and unconventional monetary policy times for various types of countries. For example, after quantitative easing, responses of most foreign asset prices to Fed monetary policy surprises increased. Lastly, it finds that advanced economies are more sensitive than non-advanced countries to Fed monetary policy surprises. It can be thus, interpreted that financial linkage and deepness can be a risk factor while preparing a macro-prudential policy[1] for the rest of the world.

Kuttner (2001), Bernanke and Kuttner (2005) and Gürkaynak et al. (2005)) all considered

[1]For more information on the Fed policy and macro-prudential policy see Claessens (2015) for a general overview, Ozkan and Unsal (2015) for the Fed policy and emerging markets and Rubio (2018) for macro-prudential policy and Euro area.

the impact of Fed monetary policy on domestic financial markets, whilst did not shed light on the international effects of the Fed monetary policy surprises. Hausman and Wongswan (2011), however, examined the effects of U.S. monetary policy surprises on international financial markets with a dataset that includes bonds, exchange rates and stock markets in 49 countries, using the event study method. Following Gürkaynak et al. (2005), Hausman and Wongswan (2011) also used two factors for monetary policy surprise and found that different asset classes responded to different factors of the monetary policy shocks during the period from 1994 to 2005. Hausman and Wongswan (2011) showed that international stock indexes react primarily to the target surprise while exchange rates and long-term interest rates respond mainly to the path surprise; and short-term interest rates respond to both surprises. Since the Fed's unconventional monetary policy in 2008, there has been increasing research into unconventional monetary policies and their effects on domestic and international financial markets (Gagnon et al. (2011); Neely (2015); Bauer and Neely (2014); Glick and Leduc (2015); Bowman et al. (2015); Krishnamurthy and Vissing-Jorgensen (2011); Rogers et al. (2014); d'Amico et al. (2012); Eichengreen and Gupta (2015)).

On the subject of unconventional monetary policy, Gagnon et al. (2011) demonstrated that the Fed's quantitative easing policy between December 2008 and March 2010 which is known as the LSAP1 had important and long-lasting impact on the long-term interest rates. Using event method around key QE announcements, they found that the QE decreased the 10-year term premium by between 30 and 100 bps for the US overall. Furthermore, d'Amico et al. (2012) and Krishnamurthy and Vissing-Jorgensen (2011) showed that the first round of quantitative easing (LSAP1) was effective in decreasing medium and long-term interest rates.

All aforementioned studies examined the impact of unconventional monetary policy on the domestic (the US) market solely. In a progressively integrative world economy and financial system, ignoring the effects of the Fed on international financial markets would not only be short-sighted but would also result in an incomplete picture. Relying on event studies of the US asset purchases, Neely (2015) found that US quantitative easing(or LSAP) had substantial effects on international long-term rates and the spot value of the dollar. The LSAP lowered bond rates in the other advanced economies by 20-80 basis points and depreciated the US dollar by 4-11%. Fratzscher et al. (2018) provided evidence that the first quantitative easing caused fund inflows in the US and an appreciation of the US Dollar, while the second quantitative easing achieved the opposite results. Bauer and Neely (2014) attempted to discover to what extent signalling and portfolio balance channels of quantitative easing led to the decline of international bond yields by using dynamic term structure models. They argued that the LSAPs had considerable signalling effects for the US,

Canada, Australia, and Germany. Rogers et al. (2014) provided evidence on international spillovers of the unconventional measures implemented by the Bank of England, the European Central Bank, the Federal Reserve and the Bank of Japan. Even though these studies (Bauer and Neely (2014); Neely (2015); Fratzscher et al. (2018); Rogers et al. (2014)) were considered at the international perspective of the Fed's impact, all concentrated solely on *advanced economies*.

In contrast, Bowman et al. (2015) followed the method in Wright (2012) by using both the event study method and a VAR to examine the determinants of developing countries vulnerability to US unconventional monetary policy (UMP). It was found that the Fed's UMP shocks lower U.S. sovereign yields, and likewise with sovereign yields in most EMEs. The interesting result is that in some cases, the effects on EME sovereign yields are larger than the effects on the U.S markets. Further, it was found that countries with high inflation rates, interest rates, current-account deficits, and more fragile banking sectors are dependent by any changes in the US. Eichengreen and Gupta (2015) investigated the effect of Fed tapering (only one event) on emerging market economies' currency, foreign reserves and stock index during the period for April 2013 and August 2013. It was demonstrated that countries those affected hardest had relatively large, liquid financial markets had permitted large increases in their exchange rates against the US dollar and their trade deficits during the Fed's quantitative easing policies, while robust macroeconomic fundamentals or capital controls did not guarantee the protection, in contrast to Bowman et al. (2015). Similarly, Aizenman et al. (2016) also employed a panel framework using daily data and find that asset prices in emerging economies reacted most to Ben Bernanke's statement, and much less to those by other Fed officials. Intriguingly, they found that economies with robust macroeconomic fundamentals were more adversely affected to tapering announcements than those with weaker fundamentals.

To the best of our knowledge, almost all studies in the literature investigate either the effects of Fed monetary policy on the domestic financial markets or advanced countries by considering the period before the recent financial crises. A study, therefore, of the effects of Fed monetary policy o the financial markets of non-advanced economies both before and after recent financial crises would bridge this literature gap.

The remainder of this paper is organised as follows: Section-2 provides an overview of the international transmission channels of monetary policy. Section-6 deals with describing the data and justifying the methodology. Section-7 offers analysis and discussions of the results. Finally section-8 outlines conclusions.

2 International Transmission Channels

A monetary policy of a core economy (the US) may not contain only a domestic impact but also may influence foreign economies through a multitude of channels, the most important of which is the exchange rate channel. Conversely, the zero lower bound period and unconventional monetary policies after the recent financial crisis led to some new channels attracting the attention of monetary policy research, namely, the portfolio balance channel, the liquidity channel, and the signalling channel in addition to the exchange rate channel (Glick and Leduc (2012); Glick and Leduc (2015); Neely (2015); Bernhard and Ebner (2017); and Fratzscher et al. (2018)).

The primary transmission mechanism for the monetary policy is the exchange rate channel. According to conventional monetary policy models, an expansionary (contractionary) monetary policy in a foreign country (in our case the U.S) induces a depreciation (appreciation) of the nominal spot exchange rate of the currency (Dollar), thus an appreciation (depreciation) of the domestic currency. For example, a change in the value of the US Dollar might have international macroeconomic spillover effects on the rest of the world through changes in import and export prices. These changes directly affect the domestic consumption and output of the real economy (Walsh, 2017).

The international portfolio balance channel, which is mainly related to bonds, implies that investors or individuals have a preference for government bonds with specific characteristics like their yields and maturity. For example, given that a foreign monetary policy focuses on large-scale asset purchasing, thereby decreasing the supply of these bonds and thus their yields, an optimising investor will re-balance his/her portfolio by considering similar alternatives internationally. In turn, the price of foreign assets increases and stimulates foreign consumption, investment, and output.

The international liquidity mechanism works directly through improved financial situations. This underlines that the large-scale asset purchasing or quantitative easing by the central bank enhances the amount of liquidity in domestic and international financial markets. This increase in liquidity in the market induces bank reserves to soar, hence, reduces the liquidity premium, allowing financial intermediaries that had been liquidity-constrained beforehand to provide credit to individuals and investors. Consequently, borrowing costs reduce and bank lending on the whole increases. This leads, therefore, to boosts in consumption and investment, both domestically and globally.

The central bank communication, which is the release of the statements, minutes of the meeting, governors' speeches, other policy announcements, reporting on the economic development, and explaining the economic expectations, creates the signalling channel. With this channel, central

banks influence the expectation of individuals and investors. Any alteration of expectation directly affects the short and long-term consumption and investment. The signalling channel applies both within a given economy as well as cross-border (international spill-overs). Through this signalling channel, an influential central bank for the world economy (such as the Fed or the ECB) induces adjustments in the pricing of domestic and global financial assets. For example, if a foreign monetary policy announcement is interpreted as indicating a downgrading of the world economic outlook, then anticipated earnings are negatively affected internationally, which also weighs on domestic stock prices. The net international spillover effects induced by foreign monetary policy compromise the sum of each effect of these different channels[2].

3 Event Study Methodology

The efficient markets hypothesis assumes that market prices adjust quickly to any new information and prices should also reflect all information available. For example, in the minutes before the information or news related to asset prices is released, its content is unknown to financial market agents. After the news release, with efficient markets, the content of the news is quickly adjusted and conveyed by financial asset prices. In this regard French and Roll (1986) and Neely (2015) showed that asset prices react relatively rapidly to news. Thus, changes in price reflects markets' reactions to the new information received before or after any changes in financial market. In other words, changes in asset prices to be correctly identified in a narrow window around the unexpected information that occurs after the news; a window which reflects no more than the *casual* effects of this news. This identification method is known as the event study technique and is used in this research.

According to recent finance literature, the event study is an appropriate method for determining the immediate effects of any surprise information on the market(Neely, 2015). The rationale for this method is that forward-looking financial markets should quickly incorporate all new information from a public announcement immediately after the announcement is made. Intuitively, financial participants would not be predicted to forgo large, risk-less, profitable trading opportunities for more than a couple of days or even hours, and thus the impact would be reflected in prices within a short period following monetary policy announcements that include new information (surprises) for financial markets. In this study, the event study technique measures the effects of monetary policy surprises by looking at the reaction of prices around a pre-defined window of the policy

[2] For more detailed discussions on quantifying the relative importance of these channels see Krishnamurthy and Vissing-Jorgensen (2011), Bauer and Neely (2014), Bauer and Rudebusch (2014), and Neely (2015)

action. This is a simple yet powerful measurement of the changes. The event study methodology is based on the efficient market hypothesis that assumes any new information available to the markets is incorporated by the related asset prices and any changes in this information set over a small time window around it, should be reflected by changes to the asset price in the very short time. The second central assumption of this method is that no other related news comes within the announcement window. In simple terms, the event study method investigates the responses of the financial markets to new information in a pre-defined window.

Given rationality in the market place or under the efficient market condition, the usefulness and effectiveness of such a method come from the fact that the impact of a related event will be conveyed shortly in financial asset returns. Therefore, a measure of the event's financial effect can be constructed using these asset returns observed over a relatively short time period which is called "the event window". Through this research, the event study method has been applied to see the immediate impacts of Fed monetary policy announcements on the financial asset prices.

Even though the event study method has a long history which goes back to 1930s, for example Dolley (1933) investigated the effects of stock splits on the nominal price changes at the time of the split. By improving this method Fama et al. (1969) introduced the event study technique which is almost the same as in use today. Amongst other Roley (1982), Fleming and Remolona (1999), Rudebusch (1998), and Ellingsen and Soderstrom (2001) are the seminal papers of the event study (MacKinlay, 1997). The method has fast become a key instrument in measuring the effects of monetary policy announcements on asset prices and economic fundamentals recently. Simply, the event study method offers a solution on measurement the effect of an event of interest over a pre-defined period. For instance, if one is looking at the effects of a recent unemployment report on stock prices with daily data, the event is here the release of unemployment report and the event window is a one-day period. Therefore, the main task of conducting an event study is first to determine the event of interest and define the period of interest. For instance, in the unemployment report case, the stock index might obtain information about the reports before the actual release and it can be examined this possibility by investigating pre-event returns. In our case, this research looks at the asset prices just before the Fed monetary policy announcement and after the announcement then investigates whether these differences are abnormal or not.

The event study method on the monetary policy analysis was popularised by Kuttner (2001). In addition to Kuttner (2001), Bernanke and Kuttner (2005) also investigated the effects of the US monetary policy news on financial asset by using the same method with daily data. Furthermore, Ehrmann and Fratzscher (2003) have applied the same method for the European Central Bank

(ECB) to the European financial markets and have found that ECB communication has considerable effects on European financial asset prices. In a similar vein, Andersson (2010) analysed the responses of exchange rates to economic news and proved that there is an important relationship between the two. Apart from central bank announcements or news, the event study method has also been used in a variety of different case. Boyd et al. (2005), for example, examined unemployment rate announcements and their effects on the equity prices in the US. It was found that if the unemployment rate was unexpectedly high, this announcement led stock prices to increase during expansion times, though, not during recession times. Rigobon and Sack (2005) showed that a rise in the probability of the war against Afghanistan in 2003 caused stock prices to decrease and increases oil futures quotes. Similarly, by using an event study Snowberg et al. (2013) further demonstrated the relationship between stock market prices and changes in perception of which candidate will win on election day.

4 Market Expectation Tool: Basic Concepts of Futures Contracts

There are many different financial market instruments to anticipate the future of monetary policy such as Treasury bills, fed funds futures, Euro-dollar futures, Euro-dollar deposits and federal funds loans, all of which differ in their liquidity and risk characteristics and thus, their ability to capture monetary policy shocks. For example, Kuttner (2001) uses the current month federal contracts, Gürkaynak et al. (2005) and Hausman and Wongswan (2011) the current month fed fund futures and Euro-dollar futures contracts, Rigobon and Sack (2003) the three-month Euro-dollar futures rate, and Ellingsen and Söderström (2004) the three-month Treasury bill rate. In this respect, Gürkaynak et al. (2007) investigated different financial market tools for forecasting monetary policy at various horizons. It was found that the best measure of surprise for the immediate policy setting is fed funds futures rates which were used by Kuttner (2001), while for a more long-term perspective, which is the expected near-term policy path rather than the immediate policy setting, it was concluded that Euro-dollar future contracts seem a better tool. Therefore, in this research, owing to their forecasting ability, the fed fund futures contracts are used to proxy the target surprise as in Kuttner (2001) while 1-Year Euro-dollar futures are used for the path surprise, similar to Gürkaynak et al. (2005), Hausman and Wongswan (2011), and Glick and Leduc (2015).

Futures contracts[3] are cash settled based upon the average daily effective target rate, as pub-

[3]CME Group's 30-Day Fed Fund futures contracts and 1-Year ahead Eurodollar futures contracts were used. These securities have been trading on the Chicago Board of Trade (CBOT) since late 1988. CME is one of the largest exchange groups in the world for more information: http://www.cmegroup.com

lished by the New York Fed, during the course of the delivery month. These futures contracts provide an efficacious means of hedging and gaining exposure to interest rate risks. In simple terms, the fed funds futures are contracts with pay-outs at maturity, relied on the average effective federal funds rate during the expiration month. Futures contracts are a valuable market predictive tool since they reflect the common marketplace insight regarding the future stance of Fed policy. According to the CME, fed fund futures have a number of key benefits. They provide a gauge of market expectations about the Fed's action at future FOMC meetings. In addition, they offer trading in transparent markets with low transaction costs, daily market-to-market and the virtual elimination of counter-party credit risk. Furthermore, futures contracts offer liquid tools to manage risk or hedge against changes in Fed monetary policy. Fed fund futures and Eurodollar futures have the same structure. In this research, one-month current contract Fed fund futures and one-year ahead Eurodollar futures contracts have been used. These contracts were introduced in the literature of monetary policy announcements by Kuttner (2001) and extended by Gürkaynak (2005).

Technically, the fed funds futures contract is quoted per the "IMM Index" or the price of fed futures contracts is 100 minus the expected Fed funds effective rate. Every contract represents the average overnight federal funds rate for the contract month. The value of the contract (ff) at expiration is $100 - r$, where r is the average effective federal funds rate over the expiry month. If the particular contract for instance, March 11, 2003 is priced 98.77, then it is understood that the market predicts the implied average fed funds effective rate for March 11, 2003 as 1.23% (100-98.77). Thus, it can be formulated:

$$\mathbb{E}[r] = 100 - ff \tag{1}$$

where $\mathbb{E}[r]$ is the expected interest rate and ff is the futures contract price.

Therefore, the market anticipation of the interest rate from the fed fund futures contracts' price can be determined at any time. For example, if the current Fed funds target rate is 1% which means that $r = 1$ and the futures contract rate is $ff = 98.770$, then the expected interest rate is;

$$\mathbb{E}[r] = 1.23\% = 100 - ff = 100 - 98.770 \tag{2}$$

$$\mathbb{E}[\Delta(r)] = \mathbb{E}[r] - r \tag{3}$$

where $\mathbb{E}[\Delta(r)]$ is the expected *change* in interest rate and r is the current interest rate.

Equation 3 implies that the market is expecting that the FOMC will increase the rate of 25 basis points ($\mathbb{E}[\Delta(r)] = 1.23\% - 1 \approx 0.25\%$) . This is due to the assumption that market participants have already priced their expectation prior to the announcements. However, if the contract price is 98.95, this suggests that the expected federal funds rates is 1.05% (100-98.95), therefore 0.05 (1.05%–1%) basis points indicates that markets do not expect any shift in rates with the upcoming FOMC meeting at that time. Moreover, the monetary policy surprise based on futures contract price is;

$$Surprise = \mathbb{E}[\Delta(r)] - \Delta(r) \tag{4}$$

where $\Delta(r)$ is the actual interest rate change and the surprise is the difference between expected change and actual change in the interest rate.

5 Measurement of Monetary Policy Surprises

In order to fully understand the effects of monetary policy, monetary policy surprises should be measured. However, measuring such surprises is not an easy task, given that the federal funds target rate and other asset prices are jump variables. This means that their price can change dependent upon changing expectations (Sargent and Wallace (1973); Gürkaynak (2005)). Thus, it is hard to identify monetary policy impact with quarterly or monthly data due to the problem of overlapping observations. In order to overcome this problem, Cook and Hahn (1989) considered the policy action as an independent variable in their research. However, the efficient market hypothesis assumes that asset prices respond only to unexpected policy actions, which necessitates the measurement of surprise components. For instance, if a monetary policy announcement contains a substantial and entirely expected change, it will not affect asset prices or portfolio reallocation, as monetary policy will already have been priced in. Hence, to have a correct estimation of the impact of monetary policy, it is vital to measure the surprise components of monetary policy, and not only use dummy variables to isolate the (monetary policy announcement) days, as is common in the literature. For example, Rai and Suchanek (2014) used a dummy variable for each Fed announcement to estimate the effects of Fed tapering on emerging market economies. The study presumed that all FOMC statements are equal and identical. In contrast, Gürkaynak (2005) and Chen et al. (2014) identified that the results are markedly different, if the magnitudes of monetary policy shocks are not controlled. Therefore, identifying and measuring the surprise components is one of the major elements of estimating the impact of monetary policy on asset prices. This section deals with the initial part of the task, namely, the identification of monetary policy surprises using high-frequency

data.

Two proxies have been used for U.S. monetary policy surprises as opposed to the single proxy used in Kuttner (2001). Gürkaynak et al. (2005) provided evidence that monetary policy surprises contain more than just a surprise in the announced target rate. Further, the study showed that two factors are needed to capture the full extent of monetary policy surprises, one for the current target rate (target surprise) or the short-term surprise and the second for the expected path of future monetary policy for the future monetary policy surprise. The target surprise is the degree to which market participants have been able to anticipate the actual monetary policy decisions. The path surprise instead measures to what extent market participants have revised the future expected monetary policy path following the actual decision and/or monetary policy statements.

5.1 The Target Surprise

The target surprise can be defined as the difference between the announced target fed funds rate and anticipations derived from the futures contracts. The target surprise is computed from the change in the current-month fed funds futures contract rate in a precise time window around FOMC announcement. These futures enable market agents to place a bet in the month t on the average effective Fed target rate during the current or future month, represented as r_{t+m}, and $m \geqslant 0$. For example, a market participant on day d in month t can get at a fixed rate at the end of the month $t+m$ thus it can be symbolised by $ff_{d,t}^{(m)}$. For instance, if $m = 0$ then the contract is for the current month t, if $m = 1$ then it is for the next month, symbolised as $t + 1$, and so forth. Thus, $ff_{d,t}^{m}$ contract rate represents the market expectation of the average effective federal fund rate, r_{t+m}:

$$ff_{d,t}^{m} = \mathbb{E}_{d,t}[r_{t+m}] + \eta_{d,t}^{m} \tag{5}$$

where $\eta_{d,t}^{m}$ is a risk premium and $\mathbb{E}_{d,t}[r_{t+m}]$ is the market expectation of the target rate on the day d in month $t + m$.

Therefore, if an FOMC meeting is scheduled to take place on day d_0 of a month $t + 0$ with total D days, the rate of fed funds futures contract $ff_{d-1,t}$ which is the one day before $(d-1)$ the announcement in the current month $(m = 0)$ would be:

$$ff_{d_0-1,t} = \frac{d_0}{D_0} r_0 + \frac{D_0 - d_0}{D_0} \mathbb{E}_{d_0-1,t}(r_1) + \eta_{d_0-1,t} \tag{6}$$

where $ff_{d_0-1,t}$ is the closing-contract price on one-day before $(d_0 - 1)$ FOMC announcement day (d_0) in month t.

Equation-6 simply shows that $ff_{d-1,t}$ is a weighted average of the fed funds rate (r_0) that has prevailed so far (d days) in the month t and the rate (r_1) is that which is expected to prevail for the remainder ($D-d$ days) of the month plus a risk premium, $\eta_{d_0-1,t}$. By evaluating the equations-6 one-day ahead which is at the end of day d_0, we can reach:

$$ff_{d_0,t} = \frac{d_0}{D_0} r_0 + \frac{D_0 - d_0}{D_0}(r_1) + \eta_{d_0,t} \tag{7}$$

where $ff_{d_0,t}$ is the contract price at the end of FOMC announcement day in month t. Note that in both equations-6 and 7, m is zero and so $ff_{d_0,t}$ equals $ff^0_{d_0,t}$ but for simplicity, this is not denoted.

Equation-6 shows the rate of the contract just one day before FOMC meeting and the second equation-7 shows the new contract rate after FOMC meeting. These equations can be used to identify monetary policy shocks. As the futures contract rate will incorporate all information available to the markets, thus, any change in the futures rate over a small time window around FOMC statements will reflect changes in market predictions. Therefore, to see FOMC meeting surprise which is the unanticipated component of the monetary policy action is given by differencing the equation-6 from 7, known as the *Target Surprise*(TS) is: :

$$TS_{d_0,t} \equiv \mathbb{E}_{d_0-1,t}[r_1] - [r_1] \tag{8}$$

$$TS_{d_0,t} = [(\Delta ff_{d_0,t}) - (\Delta \eta_{d_0,t})] \frac{D_0}{D_0 - d_0} \tag{9}$$

where $\Delta ff_{d_0,t} \equiv ff_{d_0,t} - ff_{d_0-1,t}$ and $\Delta \eta_{d_0,t} \equiv \eta_{d_0,t} - \eta_{d_0-1,t}$.

In a simple terms, the target surprise daily is defined as $TS_d = \frac{D}{D-d}(ff_d - ff_{d-1})$ where d is the announcement day and $d-1$ is the one day before the announcement, ff is the 30-days Fed fund futures. Similarly, target surprise intradaily is defined as $TS_d = \frac{D}{D-d}(ff_{\tau+10} - ff_{\tau-10})$ where τ is the time of the announcement in day d. Hence $\tau + 10$ means 10 minutes after the announcement and $\tau - 10$ is 10 minutes before the announcement.

5.2 The Path Surprise

Although the target surprise (TS) may provide the best measure of unanticipated shifts to the immediate policy setting, this research is interested in expectation changes about the future policy at the next FOMC meeting. For instance, financial agents might shortly expect a potential federal funds rate cut, however, they cannot be sure whether this will occur with the next meeting or

the meeting thereafter.To analyse shocks related to the current and future rate policy, the market expectation of average rates within specific intervals should be gauged: between the current and the next FOMC meeting, between the next meeting and the meeting thereafter, and so on so forth. These are only expectations, thus the surprises cannot be measured with the 1-month fed fund futures and so TS, in this regard, as in Hausman and Wongswan (2011) used a second surprise component, which is the path surprise, to capture the full extent of monetary policy.

Essentially, the target surprise is aimed at gauging the effects of current policy decision while the path surprise is intended to reflect news about any revision in monetary policy in the future. For this reason, in order to capture the long-time surprise, the path surprise is also used as a second surprise component. The similar method of target surprise is followed to gauge changes in expectations about r_2, the federal fund target rate that will prevail after the second FOMC meeting from now. If ff denotes the futures contract rate for the month containing the second FOMC announcement, then

$$ff_{d_0-1,t} = \frac{d_1}{D_1}\,\mathbb{E}_{d_0-1,t}[r_1] + \frac{D_1 - d_1}{D_1}\,\mathbb{E}_{d_0-1,t}[r_2] + \eta_{d_0-1,t} \tag{10}$$

where d_1 and D_1 are the day of that the second FOMC announcement and the number of days in the month containing this second FOMC meeting. Similarly, $\eta_{d_0-1,t}$ reflects the risk premium at the same as before. r_1 the interest rate after the first FOMC meeting and r_2 is the interest rate after the second FOMC meeting. Therefore, the first part of the equation-10 is the expectation of the interest rate for the first FOMC ($\mathbb{E}_{d_0-1,t}[r_1]$) on day $d_0 - 1$ and the second part of the equation-10 is the expectation of the interest rate for the second FOMC ($\mathbb{E}_{d_0-1,t}[r_2]$) again on day $d_0 - 1$. By evaluating the above equations ahead one day:

$$ff_{d_0,t} = \frac{d_1}{D_1}[r_1] + \frac{D_1 - d_1}{D_1}\,\mathbb{E}_{d_0,t}[r_2] + \eta_{d_0,t} \tag{11}$$

Thus, equation-11 indicates that r_2 needs to be predicted again with the new information available after the first FOMC meeting. $\mathbb{E}_{d_0,t}[r_2]$ denotes the expectation of r_2 on day d_0 where r_1 is already known after the first FOMC meeting. Differencing the equation-10 from the 11 then the path surprise is:

$$PS_{d_0,t} \equiv \mathbb{E}_{d_0,t}[r_2] - \mathbb{E}_{d_0-1,t}[r_2] \tag{12}$$

in detailed form:

$$PS_{d_0,t} = [(\Delta ff_{d_0,t}) - \frac{d_1}{D_1} TS_{d_0,t}] \frac{D_1}{D_1 - d_1} \tag{13}$$

where $\Delta ff_{d_0,t} \equiv ff_{d_0,t} - ff_{d_0-1,t}$ and again the risk-premium ($\Delta \eta_{d_0,t} = 0$) is constant.

6 Data and Econometric Model

This research uses daily financial market data which are domestic equity market indexes, exchange rates, and the long-term and short-term interest rates of 56 countries. Further, as in previous chapters, it uses CME Futures contracts. All asset prices data are available in Thomson Reuters DataStream and Bloomberg while future contract data is from the Genesis Financial Technologies. Following Hausman and Wongswan (2011), three-month money market interest rates are used to proxy for short-term interest rates and ten-year government bonds to proxy for long-term interest rates. Changes in equity index and exchange rate are calculated in percentage and the short, and long-term interest rates in basis point unit. We divide the dataset into parts in terms of country time and times. The period before November 25, 2008, which is the date that U.S unconventional monetary policy started is assumed as the conventional monetary policy times and thereafter is named unconventional monetary policy times. Panel (A) indicates whole period while panel (B) and (C) are for conventional and unconventional monetary policy period, respectively.

Those countries with close economic and financial links to the US or international financial markets might be affected more by U.S. monetary policy or at least differently than countries with less connection to the financial markets. In line with this hypothesis, based on the IMF (2016) specification this study splits countries into two groups; advanced and non-advanced, respectively. Advanced economies are Australia, Austria, Belgium, Canada, Czech, Denmark, EU, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand , Norway, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, United Kingdom, USA and the non-advanced countries Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Egypt, Hungary, India, Indonesia, Kenya, Kuwait, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, South Africa, Sri Lanka, Taiwan, Thailand, Turkey. In a similar vein, the first column shows the basic statistics for *All countries* while the second and third are for advanced and non-advanced countries respectively.

Table-1 provides summary statistics for all dependent variables. The first column (1) and the first panel (A) of the Table-1 show the basic statistics for the whole data sample which means the

basic statistics for all times, all countries and all announcements. Although some outlier times and responses are excluded the standard deviations of asset prices vary considerably for advanced and non-advanced countries. According to Table-1 the standard deviation (SD) of all asset prices for non-advanced countries are greater than advanced countries for all periods, without exception.

The empirical methodology of this research follows the standard event study literature by examining asset price returns over a one-day window around the FOMC announcement as in Hausman and Wongswan (2011), Neely (2015), and Bernhard and Ebner (2017). Specifically, it will estimate a panel regression for all foreign countries for each asset class using only the days on which FOMC announcements took place.

Conducting an event study research on the effects of monetary policy requires the fulfilment of at least two main tasks; measuring, firstly, the surprise(s), and secondly, the effects of these surprises on asset prices, respectively. These tasks can be best performed with high-frequency data since it is a requirement to have a small-enough window around the news, and further that nothing other than the news should be affecting asset prices. If the window is longer, other surprise information will matter too. For instance, the FOMC meeting just after the 9/11 terrorist attack on the U.S. might have an outlier effect on financial markets, therefore, the September 17, 2001, FOMC decision is excluded because of the identification challenge. It also excludes Turkey's data on August 1999 due to the earthquake, and following Hausman and Wongswan (2011); March 2001 for Argentina due to resignation of Minister of Economy; Mexico, 20 December 1994: The Tequila crisis ; Mexico, 1 February 1995: A U.S. loan package; Brazil, 12 November 1997 Brazilian stock market crises; Thailand, 2 July 1997 Bank of Thailand abandoned the baht's peg; Korea, 16 December 1997: the Korean government sold 2 banks; Indonesia, 19 May 1998: President resignation; China, 30 June 1999: rumours of that Premier Zhu Ronji would resign; Russia, 17 August 1998: de-facto devaluation announcement. Otherwise, other news will affect the asset prices and so the volume and direction of surprises.

Table 1. Summary Statistics

Periods/Variables	(1) All Countries					(2) Advanced Countries					(3) Non-Advanced Countries				
	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
(A) All Period	**From January 1996 to November 2018**														
Equity Index Change (%)	8473	0.25	1.62	-17.45	28.69	4587	0.29	1.5	-13.03	11.5	3886	0.2	1.77	-17.45	28.69
Exchange Rate Change (%)	6536	-0.08	0.8	-8.75	20.65	2617	-0.08	0.73	-8.75	4.68	3919	-0.07	0.85	-5.24	20.65
10-Year Interest Rate Change (bps)	7187	-0.44	10.12	-173	128.2	4587	-0.05	6.37	-85.9	101.6	2600	-1.17	14.66	-173	128.2
3-Month Interest Rate Change (bps)	8133	-0.29	26	-355	267.5	4624	-0.09	9.25	-199.1	218	3509	-0.56	38.54	-355	267.5
(B) Before the UMP	**From January 1996 to November 25, 2008**														
Equity Index Change (%)	4932	0.2	1.2	-10.55	8.94	2662	0.36	1.68	-13.03	11.5	2270	0.19	2.07	-17.45	28.69
Exchange Rate Change (%)	3842	-0.11	0.76	-4.7	6.88	1539	-0.07	0.71	-8.75	4.68	2303	-0.04	0.9	-5.24	20.65
10-Year Interest Rate Change (bps)	3877	0.03	10.46	-155	118.7	2662	-0.35	5.33	-85.9	33.4	1215	-1.98	15.78	-173	128.2
3-Month Interest Rate Change (bps)	4612	-0.55	18.97	-355	227.5	2699	0.09	11.13	-199.1	218	1913	-0.36	45.62	-328.00	267.5
(C) After the UMP	**From November 25, 2008 to November 2017**														
Equity Index Change (%)	3541	0.28	1.87	-17.45	28.69	1925	0.19	1.19	-10.55	8.61	1616	0.21	1.22	-4.67	8.94
Exchange Rate Change (%)	2694	-0.05	0.83	-8.75	20.65	1078	-0.11	0.74	-4.7	2.91	1616	-0.11	0.78	-3.82	6.88
10-Year Interest Rate Change (bps)	3310	-0.85	9.8	-173	128.2	1925	0.37	7.56	-58	101.6	1385	-0.46	13.58	-155	118.7
3-Month Interest Rate Change (bps)	3521	-0.09	30.27	-328	267.5	1925	-0.35	5.65	-92	97.5	1596	-0.8	27.78	-355.00	227.5

Notes: Table shows basic statistics for foreign asset prices responses to the Fed monetary policy announcements. The sample period includes all FOMC statements from January 1996 to November 2017 which totals 188 events. The period of *before* November 25, 2008, which is the date that U.S unconventional monetary policy started is assumed as the conventional monetary policy times and *after* covers from November 25, 2008, which is the date that quantitative easing policy started in the US to November 2017. This period is named unconventional monetary policy times. Advanced economies are Australia, Austria, Belgium, Canada, Czech, Denmark, EU, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand , Norway, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, United Kingdom, USA and the non-advanced countries Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Egypt, Hungary, India, Indonesia, Kenya, Kuwait, Lebanon Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, South Africa, Slovakia, Slovenia Sri Lanka, Taiwan, Thailand, Turkey.

Following Rigobon and Sack (2003), Rigobon and Sack (2004), and Gürkaynak and Wright (2013) the econometric modelling set-up is a system of two simultaneous structural equations that depend on a financial asset price. For example, stock price and a macro variable or monetary policy announcement on each other:

$$\Delta i_t = \beta \Delta r_t + \gamma z_t + \epsilon_t \tag{14}$$

$$\Delta r_t = \alpha(\Delta i_t - E\Delta i_t) + \delta z_t + \eta_t \tag{15}$$

in which Δi_t is the actual interest rate change and $E\Delta i_t$ is the expected change. Δr_t is the changes in financial asset prices which are equity index, exchange rates, and interest rates in this case. z_t is a vector of other variables that might have effects, both on the announcements (i_t) itself and the financial asset price (r_t). Lastly, ϵ_t and η_t are uncorrelated error terms.

Equation 14 denotes a monetary policy response function that covers the anticipated response of a policy to a set of other variables z_t and to the financial asset price r_t. Equation 15 is the financial asset price equation, that illustrates the asset price to be influenced by the FOMC announcements, i_t and also by the other variables, z_t.

Different from Rigobon and Sack (2003), the parameter of interest of this research is the α rather than β . The parameter of β is measuring the reaction of the monetary policy to the financial asset price changes, while this study is interested in the parameter α that measures the effects of the unanticipated FOMC announcements, $\Delta i_t - E\Delta i_t$ on the financial asset prices Δr_t.

However, it is a well-known fact that Equation 14 and 15 cannot be estimated consistently by using the ordinary least squares (OLS) due to the presence of simultaneous equations and omitted variables. Hence, the OLS estimation of the pass-through, α is biased since both variables, Δi_t and Δr_t , are simultaneously determined in the system.

To understand the difficulty of the econometric estimation, let us consider the system of Equation 14 and Equation 15 in matrix form :

$$\begin{pmatrix} 1 & -\beta \\ -\alpha & 1 \end{pmatrix} \begin{pmatrix} \Delta i_t \\ \Delta r_t \end{pmatrix} = \begin{pmatrix} \gamma \\ \delta \end{pmatrix} z_t + \begin{pmatrix} \epsilon_t \\ \eta_t \end{pmatrix} z_t \tag{16}$$

having solved, one can obtain the reduced-form solution of the system:

$$\begin{pmatrix} \Delta i_t \\ \Delta r_t \end{pmatrix} = \frac{1}{1-\alpha\beta} \left\{ \begin{pmatrix} \beta\delta + \gamma \\ \alpha\gamma + \delta \end{pmatrix} z_t + \begin{pmatrix} 1 \\ \alpha \end{pmatrix} \epsilon_t + \begin{pmatrix} \beta \\ 1 \end{pmatrix} \eta_t \right\} \tag{17}$$

Let denote σ_ϵ^2 is for the variance of monetary policy shock, σ_η^2 and σ_z^2 are for the variance of asset price shocks and other shocks, respectively. The OLS estimate:

$$\hat{\alpha}_{OLS} = \frac{Cov(\Delta i_t, \Delta r_t)}{Var(\Delta i_t)} \tag{18}$$

$$= \frac{(\beta\delta + \gamma)(\alpha\gamma + \delta)\sigma_z^2 + \alpha\sigma_\epsilon^2 + \beta\sigma_\eta^2}{\beta\delta + \gamma)^2\sigma_z^2 + \sigma_\epsilon^2 + \beta^2\sigma_\eta^2} \tag{19}$$

hence, the bias of the OLS estimate could be

$$\hat{\alpha}_{OLS} - \alpha = (1 - \alpha\beta)\frac{\beta\sigma_\eta^2 + \delta(\beta\delta + \gamma)\sigma_z^2}{\sigma_\epsilon^2 + \beta^2\sigma_\eta^2 + (\beta\delta + \gamma)^2\sigma_z^2} \tag{20}$$

According to the Equation 20 the OLS estimate is biased due to both

- simultaneity bias - if $\beta \neq 0$ and $\sigma_\eta^2 > 0$
- omitted variables bias - if $\gamma \neq 0$ and $\sigma_z^2 > 0$

To deal with this problem many studies focus on the narrow windows immediately surrounding the FOMC announcement using what has been known as event study methods that are largely used in literature such as Cook and Hahn (1989); Thorbecke (1997); Kuttner (2001); Bernanke and Kuttner (2005); Gürkaynak et al. (2005), and Hausman and Wongswan (2011).

The main logic $\beta \neq$ behind the event study method is that the bias in the OLS estimate will be limited if the following conditions hold to minimise the bias of the estimator.

$$\sigma_\epsilon^2 \gg \sigma_\eta^2 \tag{21}$$

$$\sigma_\epsilon^2 \gg \sigma_z^2 \tag{22}$$

in which case $\hat{\alpha}_{OLS} \cong \alpha$. In the limit, if σ_ϵ^2, the variance of the monetary policy shock becomes infinitely large relative to the variances of the other shocks, σ_η^2 and σ_z^2 or mathematically $\sigma_\epsilon^2/\sigma_\eta^2 \implies \infty$ and $\sigma_\epsilon^2/\sigma_z^2 \implies \infty$ therefore, the biases go to zero, and the OLS estimate now becomes consistent.

Under these circumstances, an event study with high-frequency data may offer a solution. For example, if a short enough window is considered, around an announcement, then it is reasonable to claim that the variance of shocks σ_η^2 and σ_z^2 are small, relative to the variance of the shock to the news,σ_ϵ^2. Then, Equation 15, can be simply estimated by an OLS regression of Δr_t on Δi_t. The equation is estimated over windows that include only one announcement.

Hence, the empirical methodology of this research examines asset price returns over a one-day window around the FOMC announcement specifically closing price on the day before the announcement day and closing prices of assets on the day of the FOMC announcement. Specifically, for each asset class on days in which the FOMC announcements took place, the regression is run: :

$$R_{i,x,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,x,d} \tag{23}$$

where $R_{i,d}$ is the return of country i's asset x's price (exchange rate, equity index in domestic currency, short and long term interest rates) on day d. TS is the target surprise, PS is the path surprise, and $\varepsilon_{i,d}$ is a residual term.

7 Results

7.1 Baseline Results

The average responses of domestic and international asset prices to U.S monetary policy statement announcements based on the estimation of Equation-23 are reported in Table-2. In order to compare the response of domestic and international asset price, the results are documented in two parts. The first panel (A) presents average responses for international asset prices while the second panel (B) shows the average response for U.S domestic asset price. The results of panel (B) are the same as in the second panel of Table-**??** in chapter-**??**. The positive and statistically significant estimate for the coefficients imply that international asset price returns value is positive on the 188 FOMC announcements days, and vice versa.

Specifically, our research finds that on average a hypothetical 1% (100 basis points) surprise cut in the fed fund rate (the target surprise) is associated with approximately 2% percent increase

in international stock indexes, and a hypothetical 1% (100 basis point) surprise upward revision in the future path of U.S monetary policy (the path surprise) is associated with an approximate 1% percent decrease in equity indexes. This reveals a negative relationship between US monetary policy shocks and foreign equity index returns. These results are in parallel with the findings of previous research that employ the same event study method to investigate the effects of US monetary policy announcements on daily returns of international aggregate equity index such as Ehrmann and Fratzscher (2009), Hausman and Wongswan (2011), and Chortareas and Noikokyris (2017). Furthermore, Table-2 also reports that the response of the international equity index to the short-term U.S monetary policy (target surprise) is two times higher than the domestic one (S&P 500) while both responses are approximately the same to the path surprises.

Table 2. Domestic and International Asset Prices Responses to FOMC Statements

(A)	International Asset Prices Responses					
	Target	SE	Path	SE	Obs	R-Sq
Foreign Stock Index (%)	-1.802***	(0.274)	-0.798***	(0.174)	8,473	0.011
Exchange Rate (%)	0.998***	(0.142)	0.471***	(0.0806)	6,536	0.014
Foreign 10-Year (%)	0.132	(1.323)	2.986***	(0.970)	7,187	0.002
Foreign 3-Month (%)	0.524	(1.571)	1.066	(2.521)	8,133	0.000
(B)	Domestic Asset Prices Responses					
	Target	SE	Path	SE	Obs	R-Sq
S&P500 (%)	-1.058**	(0.445)	-0.965**	(0.447))	188	0.06
10-Year (bps)	6.672	(8.540)	23.53***	(6.911)	188	0.07
3-Month (bps)	38.58***	(4.332)	5.251	(4.352)	188	0.31

Notes: Table shows domestic and international asset prices responses to the surprises of FOMC statement announcements. Responses are in daily returns which are domestic equity market indexes, exchange rates, and the long-term and short-term interest rates of 56 countries. The sample period includes FOMC statements from January 1996 to November 2017 which is total 188 FOMC statements for each country. Interest rates are in bps unit, and S&P 500 and exchange rates are in percentage change. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

For the exchange rate, which is defined as the foreign currency unit per dollar. A positive(negative) change, therefore, corresponds to an appreciation (depreciation) of the US dollar (other currency). In other words, the exchange rates' response is positively correlated with inter-

est rates in the U.S. Empirical expectation based on the literature of response of exchange rate is positive. Similarly, the exchange rate responds significantly to both surprises. In particular, it is found that a 1% (a hypothetical 100 basis points) surprise tightening (easing) in the fed fund rate (the target surprise) will lower (raise) foreign exchange rates by about 1% and a hypothetical 1% (100 basis point) surprise upward revision in the future path of U.S monetary policy (the path surprise) is associated with an approximate 0.5% percent increase in exchange rates. These findings are consistent with the results of Hausman and Wongswan (2011) and Glick and Leduc (2015).

Short-term interest rates do not respond to the U.S monetary surprises while the long-term interest rate responds significantly only to the path surprise. On average, a hypothetical 100 basis point surprise downward revision in the future path of monetary policy is associated with an approximate 3 basis points declines in foreign long-term interest rates while there is no significant response for international short-term interest rates. A possible explanation for this different reaction may be that short-term interest rates are strongly affected by the domestic central bank policy rate and other country-specific factors. In contrast, long-term interest rates are more connected to the broad global business cycle in which the U.S. economy and so the Fed monetary policy plays a significant role. In addition, these findings suggest that the results for the long-term interest rates are in line with Hausman and Wongswan (2011) while the short-term results are not. One possible interpretation of this contradiction is that this dataset spans over 21 years which is from 1996 to 2017 for 50 countries, whereas Hausman and Wongswan (2011)'s study looks at only 11 years from 1994 to 2005 for only 20 advanced countries. To understand this difference this study also looked at how the responses of advanced and non-advance countries differ from each other in the next section.

In sum, the magnitudes of the reactions of international financial asset price to US monetary policy surprises are different relative to the domestic reactions. For instance, the responses of international fixed income market prices are lower than the domestic responses while the foreign stock markets are more responsive. Therefore, it is not easy to say if either the Fed has more effect on the international market or the reverse in that it depends on the markets.

7.2 Responses of Advanced and Non-Advanced Countries in Different Times

Countries are a diverse group with their own economic stories, hence the monetary policy surprise in the U.S before and after quantitative easing might have had a different effect on financial asset markets for advanced and non-advanced economies. Equation-23 is estimated again by splitting the dataset on November 25, 2008, into the period before and after quantitative easing as well as advanced and non-advanced countries. Overall, we find that there are a number of important

differences between the response of international financial assets before and after quantitative easing to the monetary policy surprise in the US. The response of international exchange rates to US monetary shocks increase about eight times after quantitative easing. Similarly, advanced and non-advanced countries respond differently to US monetary policy in full period.

At first, we investigated the differences between responses of advanced and non-advanced countries for the whole period. The main argument of this part is that countries that have close economic and financial links to the US or the world financial systems might be affected by U.S. monetary policy different than those countries without these characteristics. In this regard, Table-3 separately documents these different responses. The magnitude of responses in stock market prices in advanced countries compared to the responses in non-advanced countries are different, and the response of non-advanced countries to the target surprise is greater than the response of advanced countries whereas lower to the path surprises. On the other hand, the responses of exchange rates of advanced and non-advanced countries are very similar to one another, and both respond significantly to both surprises.

Furthermore, without any restrictions, Table-2 indicates that on average, 3-month international interest rates do not significantly respond to any surprise of US monetary policy and 10-year rates respond significantly to the path surprise. However, when the dataset is divided into two, it appears that the response of 3-month interest rate to surprises of monetary policy is different for advanced and non-advanced countries. According to Table-3, the responses of 3-Months and 10-Year interest rates of advanced countries to US monetary policy are significant while non-advanced countries do not respond significantly. This result indicates that advanced countries, for those who likely to have more integrated characteristics to the world fixed income markets are affected more by the US monetary policy surprises. These differences between advanced and non-advanced countries are tested for statistical significance with a Chow test and the results can be seen in the appendix. The hypothesis that there is no structural break is rejected for stock markets, 10-year, and 3-month interest rates and not rejected for the exchange rate.

Table 3. Advanced and Non-Advanced Countries' Responses to FOMC Statements

International Assets	Target	SE	Path	SE	Obs	R-Sq
Stock Markets (%)						
Advanced Countries	-1.569***	(0.352)	-0.974***	(0.213)	4,587	0.012
Non-Advanced Countries	-2.078***	(0.427)	-0.589**	(0.284)	3,886	0.011
Exchange Rates (%)						
Advanced Countries	1.074***	(0.226)	0.404***	(0.127)	2,617	0.017
Non-Advanced Countries	0.947***	(0.183)	0.516***	(0.105)	3,919	0.012
10-Year (bps)						
Advanced Countries	0.117	(0.819)	2.490***	(0.661)	4,587	0.003
Non-Advanced Countries	0.161	(3.047)	3.814	(2.449)	2,600	0.001
3-Month (bps)						
Advanced Countries	4.154***	(0.771)	-0.718	(0.728)	4,624	0.005
Non-Advanced Countries	-4.132	(3.472)	3.534	(5.878)	3,509	0.000

Notes: Table shows advanced and non-advanced countries asset prices responses to the surprises of FOMC statement announcements in the US. Responses are in daily returns which are domestic equity market indexes, exchange rates, and the long-term and short-term interest rates of 56 (29 advanced, 27 non-advanced) countries. The sample period includes FOMC statements from January 1996 to November 2017 which is total 188 FOMC statements for each country. Interest rates are in bps unit, and S&P 500 and exchange rates are in percentage change. Differences between advanced and non-advanced countries statistical significance except for exchange rates. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Moreover, if we continue to divide the dataset by considering time, we can see that countries respond differently at different times. In this regard, Table-4 shows the responses of advanced and non-advanced economies in different time periods (before and after quantitative easing). The Table structure is as follows: the first multi-column is for stock markets, second is the exchange rate, the third and fourth are for 10-Year and 3-Month interest rate responses, respectively. The first

column of each multi-column such as column (1) is for all countries, and the second and third are for advanced and non-advanced countries, respectively. Panel (A) and (B) show the responses of asset markets before and after quantitative easing, respectively. For example, the response of stock markets for advanced countries after quantitative easing can be seen in Panel (B) and column (2). Further, the country classification is based on IMF (2016) report and quantitative easing start date is November 25, 2008, so before this date is represented by Panel (A) and after is Panel (B).

It was found that there are a number of important differences between the response before and after quantitative easing to the monetary policy surprise in the US. For example, as explained above, both exchange rate in advanced and non-advanced countries significantly respond to US monetary policy in the full period whereas there is a considerable difference between the responses before and after quantitative easing for both advanced and non-advanced countries. After quantitative easing, the magnitude of responses to the path surprise increased from 0.29% to 2.58% and from 0.37% to 3.05% for advanced and non-advanced countries, respectively. This is about a 9 times increase. In other words, the US dollar has increased its domination of the world currency markets after quantitative easing as a result of four times increasing the amount of the dollar (the Fed balance) in international markets. This result is in line with Rajan (2015)'s concern which suggests that the domestic monetary policy in non-US economies has been undermined by unconventional monetary policies in advanced countries after the recent crisis.

Table 4. Asset Prices Responses to FOMC Announcements

Assets	**Stock Markets(%)**			**Exchange Rates(%)**			**10-Year(bps)**			**3-Month(bps)**		
Country Type	All Countries	Advanced	Non-Advanced.	All Countries	Advanced	Non-Advanced.	All Countries	Advanced	Non-Advanced.	All Countries	Advanced	Non-Advanced.
Periods	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(A) Before	**From January 1996 to November 25, 2008**											
Target Surprise	-1.571***	-1.272***	-1.924***	0.430***	0.506**	0.378**	-0.536	-0.652	-0.396	1.163	3.874***	-2.312
	(0.319)	(0.413)	(0.493)	(0.142)	(0.236)	(0.178)	(1.335)	(0.814)	(3.077)	(1.585)	(0.788)	(3.472)
Path Surprise	-0.740***	-0.897***	-0.552*	0.342***	0.291**	0.377***	2.627**	1.686**	4.206	0.712	-0.998	3.109
	(0.182)	(0.220)	(0.301)	(0.0809)	(0.129)	(0.104)	(1.028)	(0.702)	(2.671)	(2.830)	(0.805)	(6.663)
Observations	4,932	2,662	2,270	3,842	1,539	2,303	3,877	2,662	1,215	4,612	2,699	1,913
R-squared	0.009	0.010	0.009	0.005	0.007	0.005	0.003	0.004	0.003	0.000	0.005	0.000
(B) After	**From November 25, 2008 to November 2017**											
Target Surprise	-2.761***	-2.830***	-2.679***	3.225***	3.296***	3.178***	11.17	11.75***	10.38	-14.29	10.03***	-46.17**
	(0.527)	(0.665)	(0.842)	(0.345)	(0.455)	(0.488)	(6.923)	(3.411)	(15.85)	(9.774)	(3.075)	(21.43)
Path Surprise	-1.798***	-2.241***	-1.272	2.865***	2.582***	3.053***	1.872	4.598**	-1.913	6.624	0.363	14.35
	(0.567)	(0.762)	(0.842)	(0.343)	(0.495)	(0.468)	(2.194)	(1.798)	(4.579)	(4.845)	(1.434)	(10.58)
Observations	3,541	1,925	1,616	2,694	1,078	1,616	3,310	1,925	1,385	3,521	1,925	1,596
R-squared	0.021	0.024	0.018	0.078	0.078	0.078	0.004	0.011	0.001	0.002	0.010	0.006

Notes: Table shows estimates from the regression of Equity index returns (%) on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's equity index change on day d, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC announcements from February 2000 through to January 2017. Advanced Economies and Non-Advanced Economies which are based on the IMF World Economic Outlook 2016. Equity Index is in domestic currency. Slope coefficients of the splitting sample (advanced and non-advanced countries and before and after quantitative easing) are tested with a Chow test. Differences between before and after QE are statistical significance except for 3-Month interest rate responses.

Another example is from international bond markets. Without considering sample splitting and looking only at the results of the main sample in Table-2, it can be seen that long-term foreign interest rates mainly respond only to the path surprise while the short-term (3-Month) do not significantly respond to the monetary policy surprises. In contrast, when the dataset was split in two by considering advanced and non-advanced economies there is a different picture. For instance, for the response of long-term interest rate in column (7) in Table-4, it can be concluded that the responses were dominated by advanced countries and non-advanced countries do not significantly respond to monetary policy surprises in the US. In addition, the magnitude of responses of interest rates also increased (column (8); from 1.68 bps to 4.59 bps) after quantitative easing but this shift is not as great as the exchange rate change.

Furthermore, Table-6 - 13 show each individual country's response to FOMC statement announcements for the stock markets, currency, and long- and short-term interest rates markets, for advanced and non-advanced countries, respectively. The format of each Table is similar to previous Tables. The first columns for countries and second and fourth column presents estimates on the target and path surprises, and the last column indicates the adjusted R-squared. Again, to save space we do not report constants. Each country and their asset pair are estimated separately with OLS.

Although the stock market responses, shown in Table-6 and 7, vary across countries almost all directions are the same as the domestic response which is a negative relation. Amongst others, Table-6 and 7 show that Argentina, Brazil, Canada and Mexico are those the most responsive ones. The responses of these countries to the US monetary policy surprise are greater than the domestic impact. The strong reactions of these countries may reflect the role of geographical closeness on spillover effects. Similarly, Table-8 and 9 shows individual currency reaction to FOMC statements for advance and non-advanced countries, respectively. Almost all advanced countries with free-floating exchange rate regime respond significantly to the path surprise, with the exception of Australia, Denmark, Hong Kong, Iceland and New Zealand. These countries have either too small economical linked to the US or their currency regime are not free-floating. Another important point is that most currencies in advanced countries react significantly to FOMC statements, whereas currencies in non-advanced countries react much less. This finding can be interpreted as a result of inflexible exchange rate regimes which is in consistent with Eichengreen and Gupta (2015) findings. Table-12 and 13 show the results of international interest rates' reactions to FOMC statement. It is found that most short-term interest rates do not respond to the U.S monetary surprises while the long-term interest rates respond to the path surprise.

8 Conclusion

Overall, this research finds that the spillovers from conventional and unconventional US monetary policy shocks are substantial; moreover, it further shows that in many countries the effects of spillovers on equity markets are greater than domestic impact in the US itself. In addition to Hausman and Wongswan (2011)'s paper, this research also shows that countries responded to US monetary policy shocks after quantitative easing. As a world's leading central bank, monetary policy actions by the Federal Reserve are monitored particularly among investors and other central banks. This research tries to shed some light on the link between US monetary policy decisions and international asset price reactions. The US and international asset price volatility patterns surrounding monetary policy decisions by the Fed are derived using long time series of daily data. The reaction on international markets after quantitative easing following the Fed's decisions are more pronounced compared to the reaction to the conventional times for both advanced and non-advanced countries.

The findings that Fed monetary policy has sizeable international spillovers effects on financial asset prices prompts to the question whether and to what extent the international welfare could be enhanced if these effects were considered and internalised by the Fed, in particular given as a global reserve currency, the US dollar's role on the world financial system (Ostry and Ghosh (2013); Rajan (2015); Jeanne (2014)). In future investigations, it might be possible to examine potential roles of country specific characters in the international spillovers effects. Lastly, the findings of this research are consistent with the hypothesis of an international financial cycle is driven by financial conditions in the core economy that is the US in our case and thus, lends the question as to whether and to what extent the national level monetary policy has been undermined by the Fed (Georgiadis and Mehl (2015); Rey (2015) and Shin (2012)).

9 Chow Test Results

Table 5. Structural Break Tests

	Advanced and Non-Advanced Countries		
Stock Market	F(3, 8467)	=	3.33
	Prob > F	=	0.0188
Exchange Rates	F(3, 6530)	=	0.52
	Prob > F	=	0.6691
10-Year	F(3, 7181)	=	5.44
	Prob > F	=	0.0010
3-Month	F(3, 8127)	=	3.37
	Prob > F	=	0.0177
	Before and After the QE		
Stock Market	F(3, 8467)	=	5.34
	Prob > F	=	0.0011
Exchange Rates	F(3, 6530)	=	33.96
	Prob > F	=	0.0000
10-Year	F(3, 7181)	=	6.79
	Prob > F	=	0.0010
3-Month	F(3, 8127)	=	0.85
	Prob > F	=	0.4639

10 Country Responses

Tables show that each country's response to the monetary policy surprise in the US.

Table 6. Equity Index Responses of Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Australia	-0.768	(0.996)	-0.162	(0.853)	188	0.003
Austria	-3.577**	(1.539)	-0.811	(1.318)	188	0.031
Belgium	-1.076	(1.360)	-0.536	(1.165)	188	0.005
Canada	-4.746***	(1.338)	-2.014*	(1.146)	188	0.082
Denmark	-1.778	(1.214)	-1.593	(1.040)	188	0.025
Euro Area	-0.955	(1.236)	-1.386	(1.059)	188	0.013
Finland	-2.388	(1.632)	-2.640*	(1.398)	188	0.032
France	-1.181	(1.417)	-1.225	(1.213)	188	0.010
Germany	-0.853	(1.213)	-1.834*	(1.039)	188	0.020
Greece	-0.0793	(1.848)	-2.771*	(1.583)	188	0.016
Hong Kong	-1.770	(1.489)	0.797	(1.275)	188	0.009
Iceland	1.047	(0.795)	0.735	(0.681)	188	0.016
Ireland	0.182	(1.747)	-3.467**	(1.496)	188	0.028
Israel	-3.862***	(1.228)	0.818	(1.052)	188	0.051
Italy	-0.674	(1.582)	-1.358	(1.334)	172	0.008
Japan	-3.405**	(1.519)	0.889	(1.301)	188	0.027
Netherlands	-0.897	(1.351)	-1.134	(1.157)	188	0.008
New Zealand	-1.132	(0.795)	-1.357**	(0.676)	147	0.045
Norway	-0.876	(1.412)	-1.340	(1.210)	188	0.009
Portugal	0.0654	(1.128)	-0.236	(0.966)	188	0.000
Singapore	-0.874	(1.093)	-2.590***	(0.943)	158	0.052
South Korea	-1.622	(1.681)	-1.922	(1.440)	188	0.015
Spain	-2.382*	(1.352)	-0.782	(1.158)	188	0.020
Sweden	-1.662	(1.462)	-1.880	(1.253)	188	0.020
Switzerland	-0.679	(1.106)	-0.264	(0.948)	188	0.003
United Kingdom	-0.811	(1.258)	-1.017	(1.078)	188	0.007

Notes: Table shows estimates from the regression of **Equity Index Rate (percent) change** country by country for Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's equity index change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Equity Index Responses of Non-Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Argentina	-5.717***	(1.974)	-1.768	(1.690)	188	0.051
Brazil	-6.658***	(1.969)	-2.966*	(1.686)	188	0.076
Bulgaria	3.548	(2.866)	-5.944**	(2.443)	149	0.044
Chile	-1.066	(0.736)	-2.247***	(0.630)	188	0.077
China	-2.657	(1.704)	1.712	(1.459)	188	0.019
Colombia	1.224	(0.804)	0.498	(0.689)	188	0.016
Croatia	-1.569	(1.728)	-2.161	(1.487)	180	0.018
Czech	-1.746	(1.604)	0.299	(1.373)	188	0.006
Hungary	-0.873	(1.760)	-0.561	(1.508)	188	0.002
India	-1.995*	(1.185)	-0.851	(1.015)	188	0.020
Indonesia	1.311	(1.319)	1.261	(1.129)	188	0.013
Kenya	-1.534*	(0.908)	3.359***	(0.778)	188	0.098
Latvia	-5.040***	(1.684)	-1.493	(1.439)	155	0.066
Lithuania	-1.328	(1.400)	1.692	(1.197)	155	0.017
Malaysia	-1.009	(0.880)	1.350*	(0.754)	188	0.022
Mexico	-3.962***	(1.366)	-2.991**	(1.170)	188	0.079
Pakistan	2.114*	(1.260)	0.442	(1.079)	188	0.016
Peru	-3.706***	(1.329)	-0.320	(1.138)	188	0.041
Philippines	-0.972	(1.223)	-0.754	(1.048)	188	0.007
Poland	-1.122	(1.246)	-2.999***	(1.067)	188	0.046
Romania	-3.085**	(1.545)	1.183	(1.304)	175	0.025
Russia	-2.862	(3.194)	1.412	(2.696)	175	0.006
Slovakia	-1.724	(1.072)	0.135	(0.918)	188	0.014
Slovenia	-0.873	(1.776)	0.197	(2.041)	103	0.002
South Africa	-3.175***	(1.204)	-1.187	(1.032)	188	0.045
Taiwan	-1.803	(1.241)	0.911	(1.063)	188	0.014
Thailand	-2.744*	(1.466)	-2.192*	(1.255)	188	0.036
Turkey	0.224	(1.969)	-3.565**	(1.687)	188	0.023

Notes: Table shows estimates from the regression of **Equity Index Rate (percent) change** country by country for Non-Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's equity index change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Exchange Rate Responses of Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Australia	0.686	(0.898)	-0.0288	(0.769)	188	0.003
Canada	1.394**	(0.553)	1.186**	(0.473)	188	0.068
Denmark	0.121	(0.489)	0.0880	(0.419)	188	0.001
Euro	-0.217	(0.403)	1.670***	(0.326)	188	0.130
Hong Kong	-0.0183	(0.0283)	0.0136	(0.0242)	188	0.004
Iceland	1.382	(1.263)	0.388	(1.082)	188	0.007
Israel	0.914**	(0.452)	0.611	(0.387)	188	0.036
Japan	0.620	(0.514)	1.673***	(0.416)	188	0.090
New Zealand	1.049	(0.910)	0.267	(0.779)	188	0.008
Norway	1.259*	(0.746)	1.786***	(0.639)	188	0.058
Singapore	0.582	(0.547)	0.941**	(0.391)	188	0.061
South Korea	1.512	(0.932)	-0.340	(0.798)	188	0.014
Sweden	1.647**	(0.739)	1.413**	(0.633)	188	0.054
Switzerland	2.048***	(0.869)	3.671***	(0.703)	188	0.145
United Kingdom	0.000280	(0.391)	1.274***	(0.317)	188	0.090

Notes: Table shows estimates from the regression of **Exchange Rate (percent) change** country by country for Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's exchange rate change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 9. Exchange Rate Responses of Non-Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Argentina	0.306	(0.526)	-0.0593	(0.450)	188	0.002
Brazil	1.729	(1.206)	2.538**	(1.033)	188	0.044
Bulgaria	1.289	(0.830)	1.266*	(0.711)	188	0.031
Chile	1.190**	(0.567)	1.316***	(0.486)	188	0.063
China	-0.00500	(0.0877)	-0.0231	(0.0751)	188	0.001
Colombia	1.185	(0.743)	0.0311	(0.636)	188	0.014
Croatia	1.907***	(0.634)	0.361	(0.543)	188	0.050
Czech	2.378***	(0.773)	0.966	(0.662)	188	0.062
Hungary	1.683*	(0.888)	1.816**	(0.760)	188	0.051
India	0.632*	(0.327)	0.0487	(0.280)	188	0.020
Indonesia	-0.403	(0.820)	-0.218	(0.702)	188	0.002
Kenya	0.0248	(0.480)	-0.650	(0.411)	188	0.013
Malaysia	0.0235	(0.281)	0.106	(0.241)	188	0.001
Mexico	1.887***	(0.709)	1.071*	(0.608)	188	0.055
Pakistan	-0.394	(0.277)	0.118	(0.237)	188	0.011
Peru	0.540	(0.388)	0.148	(0.332)	188	0.012
Philippines	0.802**	(0.370)	0.0277	(0.317)	188	0.025
Romania	1.378*	(0.755)	-0.312	(0.647)	188	0.018
Russia	0.453	(1.401)	0.238	(1.200)	187	0.001
South Africa	2.169*	(1.112)	0.965	(0.952)	188	0.027
Taiwan	0.0560	(0.250)	-0.0889	(0.214)	188	0.001
Thailand	0.799	(1.427)	0.590	(1.222)	188	0.003
Turkey	0.480	(0.846)	1.220*	(0.724)	188	0.017

Notes: Table shows estimates from the regression of **Exchange Rate (percent) change** country by country for Non-Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's exchange rate change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 10. 10-Year Interest Rate Responses of Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Australia	7.402	(5.114)	2.285	(4.380)	188	0.013
Austria	0.836	(3.407)	-1.315	(2.918)	188	0.001
Belgium	-1.687	(3.407)	-1.331	(2.918)	188	0.003
Canada	11.40**	(5.179)	8.295*	(4.436)	188	0.046
Denmark	-0.145	(3.661)	-2.598	(3.135)	188	0.004
Euro	-2.291	(4.111)	-0.504	(3.521)	188	0.002
Finland	14.75***	(4.846)	4.225*	(2.151)	188	0.050
France	2.590	(3.624)	3.542	(3.104)	188	0.010
Germany	3.057	(3.652)	8.912**	(3.128)	188	0.004
Greece	4.148	(15.41)	-1.768	(13.20)	188	0.000
Hong Kong	3.866	(5.559)	11.89**	(4.762)	188	0.033
Iceland	30.29	(37.34)	17.30	(33.10)	124	0.007
Ireland	2.948	(5.779)	-1.142	(4.950)	188	0.002
Israel	52.88**	(24.49)	36.12*	(19.28)	135	0.058
Italy	2.219	(4.273)	0.620	(3.660)	188	0.002
Japan	2.200	(3.186)	1.308	(2.729)	188	0.003
Netherlands	0.807	(4.012)	1.867	(3.436)	188	0.002
New Zealand	2.240	(4.276)	1.954	(3.663)	188	0.003
Norway	1.046	(3.532)	0.805	(3.026)	188	0.001
Portugal	0.691	(6.802)	4.088	(5.826)	188	0.003
Singapore	0.956	(4.008)	-2.593	(3.374)	169	0.004
South Korea	6.853	(7.583)	2.019	(6.395)	173	0.006
Spain	0.813	(4.803)	3.059	(4.114)	188	0.003
Sweden	1.725	(4.688)	-0.365	(4.015)	188	0.001
Switzerland	0.187	(2.953)	2.0282*	(2.529)	188	0.000
United Kingdom	2.915	(4.425)	6.831**	(3.790)	188	0.003

Notes: Table shows estimates from the regression of **10-Year Interest (bps) change** country by country for Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's 10-Year interest rate change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 11. 10-Year Interest Rate Responses of Non-Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Argentina	11.14	(75.89)	78.58	(86.38)	107	0.008
Brazil	12.72	(22.85)	8.250	(20.29)	128	0.004
China	-4.791	(5.354)	2.396	(4.214)	134	0.008
Colombia	20.72	(21.68)	-6.631	(19.62)	132	0.007
Czech	-7.516	(8.097)	-1.324	(6.811)	162	0.006
Hungary	-4.214	(12.98)	-3.963	(11.18)	179	0.001
India	4.942	(4.122)	3.353	(3.531)	188	0.013
Indonesia	-22.43	(34.28)	-10.24	(30.37)	126	0.004
Kenya	0.119	(13.08)	-8.237	(14.48)	118	0.003
Lithuania	1.802	(32.98)	3.096	(29.23)	127	0.000
Malaysia	9.119	(6.159)	-3.368	(4.879)	139	0.018
Mexico	20.13*	(10.51)	1.442	(8.330)	141	0.026
Pakistan	6.112	(14.97)	2.883	(16.66)	115	0.002
Philippines	13.66	(14.00)	0.762	(11.52)	146	0.007
Poland	25.27***	(8.599)	6.078	(7.366)	156	0.060
Romania	-67.44***	(25.78)	-31.46	(30.67)	92	0.078
Russia	28.21	(35.69)	-2.679	(28.54)	142	0.004
South Africa	16.74**	(6.921)	-7.905	(5.928)	188	0.037
Taiwan	-1.184	(3.974)	-2.065	(3.349)	161	0.003
Thailand	1.493	(5.834)	4.681	(5.036)	158	0.006
Turkey	176.3	(206.9)	-67.99	(174.1)	162	0.005

Notes: Table shows estimates from the regression of **10-Year Interest (bps) change** country by country for Non-Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's 10-Year interest rate change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 12. 3-Month Interest Rate Responses of Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Australia	-0.417	(9.401)	6.414	(8.052)	188	0.003
Austria	2.761**	(1.193)	2.628**	(1.022)	188	0.065
Belgium	0.168	(3.819)	-1.554	(3.271)	188	0.001
Canada	12.71**	(6.073)	8.697*	(5.202)	188	0.040
Denmark	1.803	(1.770)	-0.175	(1.516)	188	0.005
Euro	4.555	(3.384)	4.055	(2.846)	163	0.026
Finland	2.235*	(1.237)	2.418**	(1.060)	188	0.047
France	2.883	(3.187)	3.587	(2.730)	188	0.014
Germany	4.898	(3.705)	2.783	(3.173)	188	0.014
Greece	2.871	(10.94)	0.569	(9.373)	188	0.000
Hong Kong	11.17	(21.30)	2.174	(18.24)	188	0.002
Iceland	-5.085	(46.14)	17.66	(46.44)	65	0.003
Ireland	2.903	(2.211)	1.340	(1.894)	188	0.013
Israel	17.24	(11.08)	-2.458	(9.487)	188	0.013
Italy	5.031	(4.486)	3.629	(3.842)	188	0.012
Japan	0.191	(0.515)	-0.0433	(0.441)	188	0.001
Netherlands	7.703	(5.893)	1.473	(5.047)	188	0.010
New Zealand	20.87**	(10.05)	1.336	(8.611)	188	0.023
Norway	0.681	(4.543)	0.912	(3.891)	188	0.000
Portugal	2.931**	(1.257)	2.168**	(1.057)	163	0.062
Singapore	26.94	(20.43)	-14.37	(17.50)	188	0.012
South Korea	7.561	(6.812)	1.360	(5.835)	188	0.007
Spain	0.732	(4.653)	0.703	(3.986)	188	0.000
Sweden	1.446	(4.750)	2.040	(4.068)	188	0.002
Switzerland	7.145	(7.977)	-0.822	(6.833)	188	0.004
United Kingdom	-0.0904	(1.535)	-1.113	(1.315)	188	0.004

Notes: Table shows estimates from the regression of **3-Month Interest (bps) change** country by country for Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's 3-Month interest rate change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

Table 13. 3-Month Interest Rate Responses of Non-Advanced Countries

	Target	SE	Path	SE	Obs	R-Sq
Argentina	-90.38	(257.1)	-223.1	(220.2)	188	0.006
Brazil	-739.1***	(141.6)	-64.87	(138.4)	91	0.232
Bulgaria	1.891	(2.576)	-1.768	(2.288)	128	0.008
Chile	-58.77	(58.84)	-34.80	(50.96)	157	0.010
China	-0.159	(0.589)	0.0300	(0.505)	188	0.000
Colombia	-0.881	(3.531)	-1.024	(3.024)	188	0.001
Croatia	17.00	(137.6)	275.6**	(138.5)	65	0.057
Czech	-120.5**	(49.72)	-1.965	(42.58)	188	0.031
Hungary	-52.62	(32.07)	-7.488	(27.47)	188	0.015
India	-72.44***	(21.67)	4.310	(18.44)	152	0.069
Indonesia	-5.080	(81.60)	39.56	(69.89)	188	0.002
Kenya	382.8	(755.2)	-241.2	(760.1)	65	0.006
Latvia	-21.30**	(8.568)	6.603	(7.225)	173	0.037
Malaysia	7.606	(11.80)	2.398	(10.11)	188	0.003
Mexico	-26.14	(35.39)	-17.61	(30.31)	188	0.005
Pakistan	2.491	(4.902)	5.476	(4.437)	132	0.014
Peru	-0.328	(2.196)	1.532	(1.847)	163	0.004
Philippines	7.542*	(4.368)	-3.398	(3.742)	188	0.019
Poland	15.30**	(7.699)	3.616	(6.594)	188	0.023
Romania	-48.64	(95.19)	0.816	(81.53)	188	0.001
Russia	-28.69	(110.4)	121.5	(94.54)	188	0.009
Slovakia	-0.883	(54.08)	-30.99	(46.33)	188	0.002
Slovenia	22.77***	(8.717)	-0.320	(7.314)	165	0.040
South Africa	-0.291	(1.079)	-0.0318	(0.925)	188	0.000
Taiwan	8.324***	(3.196)	-0.587	(2.738)	188	0.035
Thailand	-10.01	(13.74)	0.505	(11.82)	181	0.003
Turkey	1,141***	(370.7)	221.0	(317.5)	188	0.052

Notes: Table shows estimates from the regression of **3-Month Interest (bps) change** country by country for Non-Advanced economies on the target surprise and path surprise: $R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d}$ where $R_{i,d}$ is the return of country i's 3-Month interest rate change on day t, TS is the Target Surprise, and PS is Path Surprise and both are basis point unit. The sample period includes all FOMC statement announcement from January, 1996 through November, 2017. *** p<0.01, ** p<0.05, * p<0.1.

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