The Impact of US Monetary Policy Shocks on the Exchange Rate Risk:
Connectedness of Emerging Markets

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Submitted to the
Institute of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science
in
Economics

Eastern Mediterranean University
August 2023
Gazimağusa, North Cyprus

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ABSTRACT

The US; is one of the leading countries in the world economy. Thanks to its strong economy and reserve currency, it directs the international economy. Due to its important position, the monetary policy decisions of the FED are important for other developing economies, especially small open economies. Until the 2008 Great Recession, the FED used conventional monetary policies, during and after the crisis the FED had to change its policy to unconventional due to the insufficient of conventional policies. These policy changes left a huge impact on developing countries. In particular, the impact on exports and imports has been heavier for countries with significant foreign dependence and a high external debt burden. This is also due to the changes in interest rates caused by the pressure on the exchange rate that the dollar gains value.

The study aims to explore the impact of the monetary policy shocks arising as a result of changes in the Fed's monetary policy on the exchange rate risk and the connectedness in emerging market economies. In the study, Diebold & Yılmaz spillover index was taken based and analysed by using the TVP-VAR method. As monetary policy shocks, we included Federal Funds Rate, Forward Guidance, and Large-Scale Asset Purchases. According to the result of the connectedness analysis, we found a strong connectedness among emerging market economies. Close trade relations or geographical proximity can be the reasons for this connectedness. For the transmission of the exchange rate risk between two countries, Singapore is an important risk transmitter among all countries. In addition to this, the United Arab Emirates and Qatar are in the receiver position of risk. At the end of the study, it is

determined that the US monetary policy shocks do not have statistically significant effects on the exchange rate risk connectedness in emerging market economies.

ÖZ

Dünya ekonomisinde söz sahibi ülkelerin başında, lider konumunu koruyan Amerika Birleşik Devletleri gelmektedir. Güçlü ekonomi ve rezerv para birimine sahip olması nedeniyle uluslararası ekonomiye yön vermektedir. Bu önemli konumu itibariyle, ABD merkez bankasının, FED 'in, para politikası kararları küçük açık ekonomiler başta olmak üzere diğer gelişmekte olan ekonomiler için büyük önem arz etmektedir. 2008 Küresel Krizi'ne kadar geleneksel para politikası izleyen FED, kriz sürecinde ve sonrasında geleneksel politikalarının yetersiz kalmasından dolayı birtakım politika değişikliğine giderek geleneksel olmayan politikalar uygulamaya koymak zorunda kalmıştır. Yapılan politika değişikliklerinin gelişmekte olan ülkeler üzerinde önemli izler bıraktığı yapılan çalışmalar ile ortaya konulmuştur. Özellikle ihracat ve ithalatta önemli ölçüde dışa bağımlı ve yüksek dış borç yükü olan ülkeler üzerindeki etkileri daha ağır olmuştur. Bunun nedeni olarak da faiz oranındaki değişimlerin döviz kuru üzerinde yaptığı baskılar sonucu doların değer kazanması gösterilmektedir.

Bu çalışmanın amacı, FED 'in para politikası değişimi sonucunda ortaya çıkan politika şoklarının döviz kuru riski üzerindeki etkisi ve bu etkinin yükselsen piyasa ekonomilerindeki bağlantılılığı nasıl etkilediğini araştırmaktır. Çalışmada, Diebold & Yılmaz yayılma endeksi temel alınmış ve TVP-VAR metodu kullanılarak analiz yapılmıştır. Para politikası şokları olarak FED Faiz Oranı (Federal Funds Rate), Sözlü Yönlendirme (Forward Guidance) ve Büyük Ölçekli Varlık Satın Alımı (Large-Scale Asset Purchases) kullanılmıştır.

Yapılan bağlantılılık analizi sonucuna göre, yükselen piyasa ekonomileri arasında güçlü bağlantılar bulunmuştur. Yakın ticari ilişkiler veya coğrafik yakınlık bu güçlü bağlantılılığın nedeni olarak gösterilebilir. Risk aktarımı konusunda, Singapur piyasasının önemli bir aktarıcı görevi olduğu yapılan analiz sonucunda ortaya konulmuştur. Bunun yanı sıra, Birleşik Arap Emirlikleri ve Katar risk alıcı konumundadırlar. Çalışmanın sonucunda ABD para politikası şoklarının Yükselen Piyasa Ekonomilerindeki döviz kuru riski bağlantılılığında istatistiksel olarak anlamlı bir sonuç vermediği saptanmıştır.

Anahtar Kelimeler: ABD Merkez Bankası, FED Para Politikası, Döviz Kuru Bulaşma Riski, Yükselen Piyasa Ekonomileri, TVP-VAR, Bağlantılılık

DEDICATION

To All The Lives, We Lost In The Earthquake…

ACKNOWLEDGMENTS

My first sincere thanks to my supervisor Prof. Dr. Mehmet BALCILAR for all support and guidance during the preparation of this thesis. I would like to express my thankfulness to him for not leaving any questions unanswered and for his patient interest in the thesis writing process. Secondly, I would like to express my gratitude and respect to Prof. Dr. Zekeriya YILDIRIM, who never spare his support and always believe in me more than I, did in everything. In addition, I would like to thank my all instructors in Eastern Mediterranean and Anadolu University who supports me in all cases.

My biggest thanks to my lovely family, they always help me in every situation and they believed in me for writing my thesis in a very short time. I will do my best, as much as I can, for future periods of my education life for them. And thank you my friends who support me during the hard times.

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LIST OF ABBREVIATIONS

AEs	Advanced Economies
BOJ	Bank of Japan
COVID-19	Coronavirus Disease- 19
EMEs	Emerging Market Economies
FED	Federal Reserve System
FG	Forward Guidance
FGF	Forward Guidance Factor
FGS	Forward Guidance Shock
FFR	Federal Funds Rate
FFRF	Federal Funds Rate Factor
FFRS	Federal Funds Rate Shock
FOMC	Federal Open Market Committee
FX	Foreign Exchange
GDP	Gross Domestic Product
G10	The Group of Ten
IMF	International Monetary Fund
LSAP	Large-Scale Asset Purchase
LSAPS	Large-Scale Asset Purchase Shock
LSAPF	Large-Scale Asset Purchase Factor
M9	Month-9
M12	Month-12
NPDC	Net Pairwise Directional Connectedness
OMO	Open Market Operations

OLS   Ordinarily Least Square

QE   Quantitative Easing

R-VINE   Regular Vine

SVAR   Structural Vector Autoregressive

TCI   Total Connectedness Index

TVP-VAR   Time-Varying Parameter Vector Autoregression

VAR   Vector Autoregression

VIX   Volatility Index

WWII   World War II

Chapter 1

INTRODUCTION

After the Great Recession in 2008, the world's economies try to find a new way out of this huge collapse. The countries work on monetary policies and analyze other Advanced Economies' policy decisions. The FED, which is the central bank of the US, is the most famous and important central bank for all countries in the world. The FED has some primary goals and it takes decisions in line with the goals. There are some expectations about the FED's decisions in all markets and they know that if the FED announces according to their expectations, markets are ready to respond against this action. If these actions do not match the expectations, the unexpected policy creates shocks in the countries and hence the world's financial markets. The FED uses two types of monetary policies to achieve its main aims. The first one is expected or conventional monetary policy and the second one is unexpected or unconventional monetary policy. The FED defines conventional monetary policy as changing the short-run interest rate to affect the financial and economic conditions in the country. The central bank cuts Federal Funds Rate (FFR) during the great depression and reaches the zero lower band toward the end of the recession. Therefore, the FED should find a new escape route from the deep recession in 2007-2008 and refresh economic activities after the zero lower band level of the short-run interest rates.

Then starts to use unconventional monetary policies: Forward Guidance (FG) and Quantitative Easing (QE). FG is a policy in which the central bank makes an

announcement that helps people understand about future of the monetary policy very well and these announcements make policymakers' goals more clear. The quantitative easing policy shows large-scale asset purchases and there are four sets of asset purchase programs including the maturity extension program (Kuttner, K.N. 2018).

Conventional monetary policy has some predictable impacts on the countries' macroeconomic fundamentals because countries know the result of conventional policy in the financial markets. When we consider the types of countries, the results can be different because small and emerging market countries have very sensitive macroeconomic fundamentals and financial markets but they can estimate what will be the effects for the economy. A huge impact occurs when the US has an unconventional monetary policy. Unconventional monetary policy changes the dimension and composition of the central bank's balance sheets via large-scale asset purchases or forward guidance which is the announcements about the future path of the short-term interest rate (Inoue, A., & Rossi, B. 2019). The studies are related to the spillover effects of unconventional monetary policies on macroeconomic indicators and financial markets in emerging markets or advanced economies. Most of the studies focus on emerging market economies to investigate the effect of monetary policies on the financial markets.

EME countries are very important country groups in the current literature. According to a study by IMF, in recent years, emerging markets are an ever-more significant part of the world economy and they have a growing share of global GDP. Countries are more open to external shocks because they do not have strong financial markets that can be used as a shield against crises. Although their financial markets are more volatile and prices are unstable which makes the markets too risky for investors, they

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attract foreign investors due to having a potential for growing investment phases and fast growth rates. Some studies focus on a group of countries in EMEs called the Fragile Five, the US monetary policy particularly affects these countries' exchange rates because they have mostly vulnerable currencies. Therefore, macroeconomic and financial stability depends on the stable economy in the United States. We decided to study the impact of the US monetary policy on exchange rate risk and analyze the connectedness of emerging markets for the same reason as the leading studies.

Within the scope of studies investigating the spillover impacts of the monetary policy of the U.S., different country groups, variables, and methodologies were used then they make implications and policy suggestions to these countries. Most of the studies examine how unconventional monetary policies affect economic activity in emerging market countries and selected advanced economies. Some of them result that a quantitative easing policy stimulates economic activity and supports GDP growth. However, this inference is not valid for all emerging market countries because unconventional monetary policies can affect countries differently means that each country has dissimilar characteristics. For instance, if countries have a lower GDP level and a less floating exchange rate, higher current account deficit, and higher credit risks, large-scale asset purchase policy may negatively affect the economic activities of countries. From this point of view, we can infer that differences in economic indicators change the level of exposure to financial turbulences in the US.

This study aims to investigate the effects of the Fed's monetary policy on the exchange rate risk of emerging market countries. Similar studies state the effects of unconventional policies on the exchange rates for different country groups and year ranges.

The organization of this study is as follows; Chapter 1 is an introduction part that introduces the study. The US monetary policy and types of monetary policy are explained in Chapter 2. The last part of this chapter contains six important transmission channels. In the third part, we introduce the exchange rate and exchange rate regimes. There are different exchange rate regimes in the literature, we only include two main and sub-regimes of these two. After that, we explained how is choice of exchange rate regime in emerging market economies, and why it is important for them. The main point of this study is the exchange rate risk in emerging markets and we explained this subject at the end of the chapter. Chapter 4 includes a literature review of the topic, and the previous studies related to the topic are given. The data and methodology part is in Chapter 5, first, we explained the data and some descriptive statistics then we introduced the methodology part. This section also contains the related tables and empirical results after the estimation of the data in the given period. The last section, Chapter 6, involves the conclusion part of the study. In what follows, the Appendix section is given.

Chapter 2

THE US MONETARY POLICY

2.1 The US Monetary Policy

With the increase in trade and financial integrations among the countries, the significance of the central banks is increasing from day to day. All central banks try to reach some goals for their economic and financial stability. The Federal Reserve which is the central bank of the US is the most influential central bank in the world and it became a supranational institution (Yılmaz & Alganer,2014). Decisions taken by the federal reserve are followed by all markets in the world. Effectiveness of the Dollar on international trade as a strong currency, especially small and developing countries wait for the result of the monetary policy taken by the FED with great curiosity and shape their monetary and fiscal policy according to decisions.

The Fed is responsible to achieve some goals including maximum employment level, stable price levels, and acceptable long-run interest rates, stability in financial indicators, similar to the other central banks' targets. The Fed's duty for monetary policy is mostly known as the dual mandate which includes maximum employment level and stability in inflation. Monetary policy decisions are taken by the Federal Open Market Committee (FOMC). Until the Great Recession strikes the whole economic system, traditional monetary policy tools work well to achieve the FED's primary goals, commonly known as changing the target rate of Federal Funds.

With the recession, the FED started to decrease target rates near to zero and then realizes that it could no longer use the primary monetary policy tool.

2.2 Types of US Monetary Policy

During the Great Recession, 2007-2008, the whole economic activities harshly decline and countries start to seek urgent solutions to overcome severe collapse in the economy. The FED uses a way that cuts the federal funds rates until zero lower bands, after that it needs more than the federal fund rates. Therefore, the FED adopts unconventional monetary policies to support financial stability and economic development in the country.

Since the recession is over, researchers and policymakers begin to talk about these two policies and it becomes a famous research topic around the world. Therefore, the next sections give details about two types of monetary policies that are conventional and unconventional. Many studies use traditional and untraditional or expected and unexpected to define newly introduced monetary policies. We prefer to use conventional and unconventional monetary policy in this study.

2.2.1 Conventional Monetary Policy

The Federal Reserve uses conventional monetary policy tools which are Open Market Operations(OMO), Reserve Requirements, and Discount Window Lending to achieve its main goals. The FED executes the country's monetary policy by changing the short-term interest rate and affecting the availability and cost of credit in the economy. Before the recession in 2007, the Federal Reserve bought or sold securities issued or backed by the US government in the open market on most businesses days to keep a key short-term money market interest rate called the Federal Funds Rate at or near a target set by the Federal Open Market Committee (FOMC). To support the economy

during the financial crisis that began in 2007 and during the ensuing recession, the FOMC lowered its target for the federal funds rate to near zero at the end of 2008. In the fall of 2014, with the economy having made substantial progress toward maximum employment then the FOMC announced key elements of its plans for normalizing monetary when it's possible. In December 2015 the FOMC decided that economic conditions warranted starting the process of policy normalization and voted to raise its target for the federal funds rate.[1]

The FOMC modifies the monetary policy by increasing or decreasing the target for the federal funds rate. Decreasing the target range for the federal funds rates means an easing of monetary policy and increasing the target range represents a tightening of monetary policy in the literature. Changes in the target range for the federal funds rate shape the spending decisions of households and businesses. Therefore, the FED's assessments of the general picture of the economy and its goals concerning the federal funds rate become a most important policy new not only in the US but also in the rest of the world.

2.2.2 Unconventional Monetary Policy

The turning point after the great depression for the FED is a mandatory change in the monetary policy from conventional to unconventional policies. After reaching the zero lower band, the central bank plays the same role that is providing economic and financial stability back, with a different scenario which is using Forward Guidance and Large-Scale Asset Purchase (LSAP) or Quantitative Easing policy.

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[1] The 11th edition of The Fed Explained: What the Central Bank Does (formerly The Federal Reserve System Purposes & Functions) Chapter3 Conducting Monetary Policy, August 2021

Forward guidance has become an increasingly important tool of monetary policy in recent years (McKay, A., Nakamura, E., & Steinsson, J.B.,2016). Forward guidance is a form of communication between the FOMC and the public. Through forward guidance, FOMC gives significant signals for the future purpose of the monetary policy. Forward guidance is an important policy, not only during the recession but also after the crisis period, for policymakers because they use it for several years to provide a better understanding for the public. According to Campbell et al. (2012), when the federal open market committee says, we anticipate that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time, it gives a direction to decisions of households and businesses. The language is important that the committee uses while making an announcement. Campbell et al. (2012) introduce two types of forward guidance to the literature; Delphic and Odyssean forward guidance. In this study, we only give a short definition of each of them. Delphic forward guidance covers only the monetary policy position and economic outlook. It focuses on the response function of monetary policy. According to the Federal Reserve Bank of Chicago, Odyssean forward guidance shows the deviations from the interest rate rule, it points to the future deviation of the FOMC from main policies.[2]

The other type of unconventional monetary policy is the Large-Scale Asset Purchase or Quantitative Easing policy that is used first by the Bank of Japan (BOJ) in 2001. This is the second way for the FED for recovering the economy after the great recession. The aims of making large-scale asset purchases are, to put pressure on long-term interest rates, support financial conditions, and improve economic activities by

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[2] For extensive information about types of forward guidance can be access from the study of Campbell et al. (2012).

creating job opportunities. Between 2008 and 2014, there are three asset purchasing stages, and the maturity extension program (September 2011- December 2012) is included in these three rounds. While the LSAP increases the size of the balance sheet of the Federal Reserve, the maturity extension program puts pressure on the long-term interest rate without changing the size of the balance sheet. Thanks to large-scale asset purchases, the cost of credits decreases and provides more available credits to the markets.

Most of the studies focus on the quantitative easing policy and its effects on economic indicators. Purchasing assets means that the central bank purchases government bonds and long-term securities and causes to increase in the money supply. Not only struggle with the great depression (2008-2014) but during other crisis periods like the recent crisis which is Covid-19, the FED adopts a quantitative easing policy until it achieves stability in the economy.

2.3 The Transmission Channels of Monetary Policy

The monetary policies are determined according to the central bank's targets for price stability and sustainable growth rates. In the direction of these targets, the central banks use conventional and unconventional monetary policies and they can affect the economy through transmission channels. These channels are; interest rate, exchange rate, asset prices, signaling, and portfolio balance. The impacts of these channels are investigated in different studies separately. Due to the different approaches of researchers in the studies, there are different numbers of transmission channels in the literature. We focus on the same channels mostly focused on by different authors in preceding studies.

2.3.1 Interest Rate Channel

The money market is directly affected by any changes in interest rates. The deposit and lending rates of banks are indirectly affected by interest rate changes. For instance, if the central bank decreases the interest rate as a result of easing monetary policy, the interbank interest rate decreases, and the money supply increases. There is pressure on the general price level due to increasing money in circulation. Households raise their consumption expenditure because of fear of higher inflation in the future. As a result, aggregate demand raises in the economy. The interest rate channel is examined as a transmission channel of conventional and unconventional monetary policy.

2.3.2 Exchange Rate Channel

The exchange rate has an evident effect on economic activity and inflation rates. It is closely related to changes in interest rates. If a central bank implements an expansionary monetary policy, it leads to decreasing interest rates and this country has a lower interest rate compared to the rest of the world. Due to the decline in the rate of return on investments, the investors start to seek higher-return assets and demand for domestic assets falls. As a result, demand for the domestic currency decreases in the foreign exchange market and the domestic currency depreciates. The export goods become cheaper as a consequence of depreciation in the domestic currency. On the other hand, imported goods are more expensive, and demand for imported goods decreases. An increase in net export stimulates economic activities and causes to inflation raise. The exchange rate channel creates inflation in two ways. Depreciation in domestic currency makes costlier to the production of some goods that need importing inputs. Therefore, the exchange rate channel can create cost-push inflation in the economy. The other type of inflation is demand-pull inflation which occurs due

to an increase in demand for export products. Total demand exceeds the total supply and firms increase the price of products, the result is inflation.

2.3.3 Asset Price Channel (Stock Price Channel)

Brett R. Ubl (2014) states that negative monetary policy shocks resulting decrease in interest rates make borrowing easy and cheap for economic agents. Households can borrow more from lenders because the cost of borrowing is very low. A fall in interest rates fuels demand for assets. It induces a high level of investment in the economy. Hajdukovic (2022) concludes that after decreasing interest rates, firms can buy more investment goods and it resulting in higher economic output. Higher demands for assets give rise to an increase in asset prices thus there is an improvement in people's wealth. It leads to a high level of consumption in the economy.

2.3.4 Credit Channel

Bernanke & Gertler (1995) conclude that conventional monetary policy has some shortcomings and the credit channel tries to solve these puzzles. In their research, they explain what are the shortcomings that arise from conventional monetary policy and how the credit channel be a solution to these problems. The credit channel helps to understand the response of the demand and output to monetary policy shocks (Hernando, I. 2014). When the central bank decides to follow an easing monetary policy, lower interest rates affect the supply of credit due to a lower risk of the borrowers paying back their loans. The credit channel makes access easier to the capital markets and this convenience causes to increase in the demand for credits by households and firms. Thus, economic activities increase as a result of rising consumption and investment (Hajdukovic, I. 2022).

2.3.5 Portfolio Balance Channel

After the announcement of the Lehman Brother's bankruptcy, the Fed rises the size of its balance sheet and decreases the federal funds rate near to zero by adopting unconventional monetary policies which are quantitative easing or large-scale assets purchases and forward guidance. Daniel L. Thornton (2014) clarifies that Fed uses unconventional monetary policy (large-scale asset purchases) to fuel aggregate demand and investment by reducing the long-term rates via two transmission channels which are the portfolio balance and signaling channels.

In the previous studies' statements, the quantitative easing policy works by way of the portfolio balance channel. This channel has a key role in the expected transmission of large-scale asset purchases to the economy. Owing to the portfolio balance channel, central banks can change the supply of assets by making asset purchases that are held in the private sector and cause to reduce their yields. Therefore, the financial assets suppliers try to rebalance their portfolios by purchasing assets that have similar characteristics to assets already sold to the central bank. As a result of this process not only asset prices but also prices of other close substitutes go up and reduce their yields (Goldstein, I., Witmer, J., & Yang, J., 2018). Economic activities grow due to households, they make high levels of spending and consumption (Hajdukovic, I. 2022).

2.3.6 Signaling Channel

Communication is an important tool not only for people to clearly understand each other but also for the central banks to announce their future policy stance to the market participants. The announcements give signals about the views of central banks on economic conditions and the path of future policy rates. For instance, in the case of

large-scale asset purchases, the Fed announced LSAPs and this news gives a signal that the economic outlook is worse than the expectations, therefore policy rate is close to zero for a longer period. The signaling channel states that central banks can reduce the long-term interest rate by decreasing expectations of the short-term interest rates (Bauer, M.D., & Rudebusch, G.D., 2011).

Within the scope of the signaling channel, following the advanced economies' monetary policy is a significant subject for emerging market countries and other small countries to stabilize their exchange rates. The lower policy rate signals via asset purchases affect the long-term government bond yields. Aggregate demand and credit demand can increase by falling interest rates, increasing consumption, investments, and the price level in general (Hajdukovic, I. 2022).

Chapter 3

THE EXCHANGE RATE

3.1 The Exchange Rates

With the world economy becoming more globalized, there is more interaction between nations every day, and they continue to have an impact on one another through various economic and social ties. Some important indicators affect each country's economic conditions in different aspects. Therefore, the world economy pays attention to indicators and follows the changes, especially in the advanced economies, of these indicators with great importance. The exchange rate is one indicator that mostly affects international trade, financial transactions, and domestic economic activities.

There are many currencies in international trade due to the number of countries in the world, therefore international trade and investments among the countries need to exchange these currencies to make healthy transactions. The currency of a country is a tool for payment between two countries in international transactions and the exchange rate is the rate of exchange between two currencies. Countries can make exports and imports depending on the exchange rates. The exchange rate enables us to compare different prices of goods among the countries and facilitates the money transfer among them. Any changes in the exchange rates have several effects on the countries' economic activities because a stand of currency can create uncertainty and instability in the economy.

At the end of WWII, the Bretton Wood system started to measure the exchange rate movements. In the late 1970s, the exchange rate began to determine by the demand and supply in the foreign exchange market. Demand rises for any currency leads to an increase in the value of that currency and as a result domestic currency depreciates. The value of the currencies describes the level of competitiveness of that country in international trade.

The exchange rate arrangement is not a direct target of the monetary policy but monetary policy has direct or indirect effects on the exchange rate. Monetary authorities try to keep the economy stable by using monetary policy tools. Economic growth, the minimum level of unemployment, price stability, and long-run or short-run interest rate goals of central banks can affect the exchange rate in the country. Monetary policy is an important factor that affects the exchange rate in small and emerging market economies. Monetary policy shocks, both within the country and in other advanced countries have major impacts on the exchange rate volatility and it creates risks for trading countries. Therefore, the relationship between monetary policy and the exchange rate attracts the attention of policymakers and researchers recently.

Most of the studies focus on the US monetary policy due to the dollar's effects on the world economy. In particular, financially vulnerable countries are affected more by external shocks. Therefore, the Fed's monetary policy has a significant spillover impact on emerging market economies. The exchange rate behavior against monetary policy shocks is another research area and the most famous work in international finance is Dornbuch's (1976) Expectations and Exchange Rate Dynamics.

He predicts the exchange rate initially overshoots its long-run level to adjust the monetary policy shocks (Faust, J., & Rogers, J.H.,2003).

There are different ideas about the exchange rate arrangement of the countries when they respond the monetary policy shocks. Different studies such as Bowman, D., Londono, J. M., & Sapriza, H. (2015), Hausman, J.K., & Wongswan, J. (2006). and Degasperi, R., Hong, S.S. & Giovanni, R. (2020) infer the same results regarding the significance of the exchange rate arrangements in small and emerging markets economies. The next section clarifies exchange rate regimes.

3.2 The Exchange Rates Regimes

The exchange rate is an important tool for countries to realize commercial and financial transactions with each other. The choice of exchange rate regime is another important issue for them because they have to follow an appropriate regime for their economic conditions. There are different types of exchange rate regimes, countries choose the best regime which is convenient for their needs and supports the monetary policy in the economy. Before choosing the exchange rate regime, countries should describe their specific circumstances, then decide which exchange rate regime and related policy they follow.

According to IMF Annual Report (2022) about exchange rate arrangements and exchange restrictions, there are four categories of exchange rate regimes that depend on two main regimes that are Fixed (Pegged) Exchange Rate and Floating (Flexible) Exchange Rate Regimes.

3.2.1 Fixed (Pegged) Exchange Rate Regime

Under the Fixed or Pegged Exchange Rate Regime, the central banks specify the exchange rate by selling and buying currency transactions. The aim of using a fixed exchange rate regime is to minimize volatility and keep rates equal or close to the target level. Fixed exchange rate regime limits adjustment of the central bank for the interest rate as needed for economic growth and requirement changes to support the currency. Therefore, pegged exchange rate regime is not an automatic stabilizer in the economy. Adam Hamilton (2018) maintains that the central bank can lose control of monetary policy power because it is not independent of the intervention in the exchange rate market. The pegged exchange rate regime has two categories which are Hard Peg and Soft Peg regimes. The country's currency is directly fixed to another country's currency and without any changes in the domestic currency until the other currency depreciates or appreciates which is called a hard peg regime. The central bank does not have control of monetary policy because they are strictly unwilling to change the exchange rate and they tend to hold at the same level until they face any structural changes in the economic conditions. The soft peg exchange rate regime is the opposite version of the hard peg in that governments can use different tools to solve shocks in the economy. The soft peg arrangement has sub-categories and this study only mentions some of them which are used by the countries that are in our country group. A conventional peg is one of the soft peg arrangements and the country formally pegs the currency to another currency at a fixed rate. The authorities intervene in the exchange rate market to keep the exchange rate at a fixed level. The stabilized arrangement is the spot market rate which is not flexible but it stays at a margin of 2% for six months or more. The exchange rate is stable due to official actions (Wang, Y.2022).

The last one is the craw-like arrangement that suggests the exchange rate should stay within a close range of 2% concerning statistically described for six months or more. Ghosh, A., Gulde, A. M., & Wolf, H. (2002) state that the fixed exchange rate ensures the currency's stability for some time and makes financial transactions less volatile and more controllable.

3.2.2 The Floating (Flexible) Exchange Rate Regime

The floating (flexible) exchange rate regime is a widespread type of exchange rate regime in the world, mostly the advanced countries use the floating regime. Under the floating (flexible) exchange rate regime, demand and supply in the foreign exchange market determine the value of the exchange rate. Monetary authorities keep fewer foreign currency reserves in the bank because they less intervene in the exchange rate market. The most important advantage of that regime is its contribution to macroeconomic and financial stability by decreasing the impacts of shocks. This regime assists the monetary policy to achieve targets in economic conditions. Therefore, the floating exchange rate regime is seen as an automatic stabilizer in the economy. There are two types of floating exchange rate regimes in the literature: free-floating and managed floating regimes. In the free-floating regime, central banks only intervene in the exchange rate if there are aberrant situations in the economy. Managed floating exchange rate regime occurs when the central bank intervenes in the exchange rate market to define the exchange rate but not fixed it. The authorities keep it as a float when the financial markets are stable, on the other hand, if there are fluctuations that are the sources of uncertainty in the economy, the market needs intervention by monetary authorities to become stable as before.

3.2.3 The Choice of Exchange Rate Regimes in Emerging Markets

The choice of a convenient exchange rate regime is an important issue for emerging markets and also other countries in the world economy. Due to infrastructural differences, each country chooses a different exchange rate regime that is suitable for the economic conditions. Emerging market economies are a special group among whole countries because they are more vulnerable to financial shocks. Therefore, after the recent financial crisis, they need to change their exchange rate preferences from fixed to flexible to reduce fragility in the economy. Edwards et al. (2003) point out that emerging market countries should change their exchange rate regime to prevent exposure to the financial crisis and they have to adopt credible exchange rate regimes. According to this idea, credible exchange rate regimes should have the power of reducing capital outflows from emerging market countries.

Another issue, as significant as the choice of the exchange rate regime, is the question of how countries determine their choices or according to which criteria they decide on the regimes. With the development of the world economy, many global changes occur and countries should pay attention to these changes to adopt correct exchange rate regimes. Global changes affect the connectedness of the currencies because international networks among countries lead transmission of shocks and also risks from one country to another and have impacts on the performance of the foreign exchange markets. Especially the rise in capital mobility and trade flows, within emerging market countries and also with other advanced countries, bring the necessity of changes in regime preferences and the need for strong institutions to implement new decisions.

Casiraghi, M., Habermeier, K., & Harjes, T. (2022) indicate criteria based on some approaches which are improved in the framework of the Mundell-Fleming Model for choosing a suitable regime for countries. They explain the criteria that countries cannot target three policies at the same time. It is also knowns as the Impossible Trinity[3], which is introduced by Frankel, J.(1999), in the literature states that a country should follow two of the three aims which are; stability in the exchange rate, free capital mobility, and independency in monetary policy. Therefore, the exchange rate arrangement in emerging market economies has to be consistent with the policy stance of the monetary authorities. Another criterion is the arrangement should be related to the country's fundamental characteristics because each country has different challenges with different problems and the country's policy priority is different. Emerging market countries have more vulnerable economies and their priority policies are strong and less volatile financial markets, price stability, and free capital flows. Within these policies, they should follow the flexible exchange rate regime because they see the flexible exchange rate regime as a shock or risk absorber. [4]

3.3 Exchange Rate Risk in Emerging Markets

Strong international economic connections, put forward the significance of the exchange rate for small open market economies due to the power of the advanced economies' currencies in international transactions. Investors, especially in emerging market economies, should consider and manage their investment decisions based on the risk and return performance of the currencies. The exchange rate diversity creates some risks for investors. Unexpected or expected changes in the exchange rate

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[3] For further information, see No Single Currency Regime is Right for All Countries or at All Times by Frankel, J. (1999).
[4] For further information about the choice of exchange rate regime criteria, see the Choice of Exchange Rate Arrangement. *Monetary and Capital Markets Department,* TECHNICAL ASSISTANCE HANDBOOK, IMF.

stimulate the rebalancing of the portfolios. In the end; investors will show a collective action and all of them rebalance their investment portfolios due to the probability of volatility risk in currencies. This behavior drives the spillover effect in the currency markets (Greenwood-Nimmo, M., Nguyen, V.H., & Rafferty, B.J. (2016).

The exchange rate risk is explained with different approaches in the literature and the most widespread use is exchange rate contagion. The definition of contagion is also important and we use the definition of Forbes and Rigobon (2002). They explain the contagion is a considerable increase in links between the international markets. In other words, any shock in one country affects the other markets in different ways.

After the subprime mortgage crisis in the US, the usage of contagion became more popular to explain the transmission of the impacts of the crisis. Depreciation and appreciation in the exchange rates create different results in different groups of countries according to the power of currencies. Loaiza-Maya, R., Gomez-Gonzalez, J.E., & Melo-Velandia, L.F. (2015) focus on the exchange rate contagion in Latin American economies. They find that there is a strong exchange rate contagion in these countries. To decrease contagion risk, they suggest that these countries should follow a convenient exchange rate policy and choose an appropriate exchange rate regime. During the appreciation periods, contagion risk is higher than at depreciation times. In crisis periods, the markets are always unstable and the risk is very high in emerging markets economies.

Therefore, emerging market economies should follow the direction of the movements in the exchange rate during the global domestic crisis time to decrease exposure to the contagion risk. In addition to all this, these countries should pay attention to their

economic policy and political relations with other countries because they have unstable economic policies and some of the countries have depressed foreign relations. This is because; sensible economic policies help to decrease the exposure of the risk and close moderate foreign relations help to find cash needs in times of crisis. These situations can affect the contagion risk between them.

Different from the literature, we focus on the exchange rate contagion risk in emerging market economies in this study and we try to find after any shocks in the US monetary policy, how the exchange rate contagion risk occurs in emerging market economies. We analyze the US monetary policy first and which conditions cause to change the monetary policy. The policy changes affect the financial markets due to the dollar is the widely accepted currency in transactions in the world economy. The currency changes, appreciation or depreciation in the US dollar, influences the countries' economic conditions and this affects spread around the world. This spreads create some risks on the small open market economies and we focus on emerging market economies to investigate how is the risk transmission for this group of countries.

Chapter 4

LITERATURE REVIEW

Several studies state the impact of U.S. monetary policy on the exchange rates, equity prices, interest rates, inflation rates, industrial production levels, etc. for different periods. Our literature review includes some studies analyze the effects of the US monetary policy on the US financial markets and economy as a whole while others examine the effects on different country groups such as small, developing, emerging markets, and advanced countries. One of these studies is by Bowman *et al.* (2015) investigate the effects of US unconventional monetary policies on sovereign yields, foreign exchange rates, and stock prices in emerging market economies using data from the beginning of 2006 to the end of 2013. They include 17 emerging market economies and analyze how US unconventional monetary policy effects vary according to country characteristics. They state that the exchange rate regime for each country is an important tool for explaining the transmission of the effect of United States monetary policy in emerging markets. They pay attention to the type of exchange rate regime and in countries that are using a managed floating exchange rate regime, sovereign yields are more exposed to changes in US monetary policy than in countries using a free-floating exchange rate regime. As a result, the authors find that U.S. monetary policy shocks have a remarkable effect on sovereign yields in most of the countries in the study.

For the spillover effects on the US markets, Balcilar et.al (2020) investigate the effects of unconventional monetary policy which is quantitative easing on the volatility spillover on the stock, bond, foreign exchange, and commodity markets within the US financial markets. They include data from December 1996 to November 2018. The authors use a STVAR model, which is a different study in the literature by introducing a new spillover index, and expanding the spillover index of Diebold and Yılmaz to the regime-dependent positions and then forecasting the regime-dependent spillover indices in the US financial markets. The study results that the US financial markets' volatility spillover is different during the bustling periods relative to the serene periods. For the bustling period, economic situations like the global financial crisis or large-scale asset purchase programs, change the regime, and through the transmission channels, they affect the volatility of asset prices. As a result, after the quantitative easing policy, the total volatility spillover in the US financial market increased. The behavior of volatility spillover changes depending on the announcement of the quantitative easing due to switching regimes. They conclude that stock markets' position changes from net volatility transmitter to neutral after the announcement of the quantitative easing programs. For the bond markets, when quantitative easing starts, the risk spillover is sharpening from the bond market to the others. In conclusion, they report that the transmission of financial shocks is important and policymakers should pay attention to these volatility shocks because they cause imbalances in the general economic outlook.

Various studies maintain the spillover effect of US monetary policy, Riccardo Degasperi *et al*. (2021) is an important source to understand the global spillover effect of US monetary policy by using big data. They involve Advanced Economies, EMEs,

and Euro Area countries that have big economies and use the floating exchange rate regimes with capital mobility in the market. They state that degree of openness to capital movements and exchange rate regimes are two important measurements to clutch the spillover effects of US monetary policy globally. In line with the countries studied in the Euro Area, the authors suggest that if the Fed follows a tightening monetary policy, Euro Area starts to endure recessionary effects, and tightening monetary policy deteriorates internal economic conditions. The authors investigate the effect of monetary policy on advanced and emerging market economies in different ways. They use the median response of these countries when they analyze impulse responses. As a result, a contractionary monetary policy shock causes a slump in advanced economies. The outcome of the US monetary policy is not different for emerging market countries. With an unexpected tightening monetary policy in the US, the financial condition in median emerging market countries deteriorates. The national currencies depreciate, inflation increases, and the result is decreasing in output level. They claim that the spillover effect of US monetary policy is more powerful in EMEs than AEs.

Many studies remark on the effects of the US monetary policy by focusing on the Quantitative Easing policy. Tillman (2016)'s study is one of them and examines the effects of unconventional monetary policy, which is Quantitative Easing(QE), always taken into account which has a significant spillover effect on emerging market economies, by using monthly data between 2007 and 2013. The author explains the effect of the QE policy on the financial conditions of emerging market economies with the 2008 global crisis. The A Qual VAR model is used to estimate the effects of QE policy.

The estimated model includes both US macro data and indicators of financial conditions in emerging markets. In conclusion, an unexpected change in US monetary policy decreases bond spreads and increases equity prices, capital flows to emerging markets, and currency appreciation strongly. A similar study by Bhattarai, S., Chatterjee, A., & Park, W.Y. (2015) estimates the international spillover effects of the FED's unconventional monetary policy on emerging markets by using macroeconomic and financial monthly data from January 2008 to November 2014. In the empirical part of the study, they follow two ways; they estimate structural VAR to determine the QE shocks for the US and then they follow a panel VAR model to identify the effect of QE shocks for the EME countries. The study uses data on output, prices, the stock market index, long and short-term interest rates, bond index, trade flows, monetary aggregate data, and capital flows. This paper first focuses on the domestic effects of QE and finds the fast effect on consumer prices, this is a different result from the existing literature. They continue by looking at the spillover effects of QE and find that when a positive QE shock occurs the currencies in emerging markets appreciate remarkably towards to US dollar. The reason behind this appreciation is an increase in money supply will decrease the interest rate in the US then investors in financial markets tend to turn to the higher yielding markets which are located in the emerging market economies and the result is an asset market boom. The effect is felt stronger in the Fragile Five countries which are Brazil, India, Indonesia, South Africa, and Turkey. The study is a good guide for open market economies to understand the unconventional monetary policy transmission mechanisms and spillover effects.

Fratzscher, M., Lo Duca, M., & Straub, R. (2012) study the spillover effect of unconventional monetary policy (QE) on portfolio flows and asset prices from the beginning of the global financial crisis worldwide. The authors prefer to look at two different times when the QE policy was applied. The first part is QE1, which includes data from 2007 to 2009 and the second part includes data from 2010 which is called QE2. They use the panel regression method to examine 65 countries which are the US, emerging market economies, and advanced economies. In the study, three channels are related to the US monetary policy changes and these channels show how they affect the investors' portfolio decisions and equity prices in general. The result of the study varies from QE1 to QE2. The QE1, between the years (2008-2009), causes a clear appreciation in the US dollar. The appreciation supports equity markets and attracts capital inflows to the US. During the second unconventional monetary policy process, QE2 (2010), it works completely reverse because the policy causes capital flows to the Emerging Market countries. The policy of QE2 stimulates harsh depreciation in the US dollar. The results show how Fed monetary policy encourages portfolio redistribution in financial markets since the global crisis appeared.

Chen *et al.* (2016) analyze what are the effects of unconventional monetary policy on 17 advanced and emerging market economies by using monthly data between 2007-2013 and estimate a global vector error correction model (GVECM). They argue that US monetary policies, regardless of policy type conventional or unconventional, have a considerable impact on both domestic and global economies. On the other hand, there is a widely accepted idea that the quantitative easing policy, after the global financial crisis, helps to recover global financial markets and try to prevent further downfall in economic activities in the world in the years 2009 and 2012. For example, LSAP1

(large-scale asset purchases), protected against a long recession process and deflation in the US and also other countries. The paper finds that emerging market economies feel the effect of QE more than advanced economies. In some emerging market economies, the policy of QE creates an overheating effect in 2010 and 2011, but in the following years, it helps to recover the economy. The degree of feeling of the effects also differs, depending on country-specific characteristics as mentioned in previous studies and the results are consistent with the literature.

Yildirim, Z., & Ivrendi, M. (2021) work on the effects of the US unconventional monetary policy, commonly known as a large-scale asset purchase or quantitative easing, on 20 emerging markets and 20 advanced economies using SVAR (structural vector autoregressive) models with high-frequency daily data. They use two spreads as indicators of US unconventional monetary policy; term and mortgage spreads. They estimate the daily SVAR model, the variables for the U.S. are term and mortgage spreads and VIX as a measure of risk appetite. The variables for emerging markets are long-term interest rates, equity prices, exchange rates, and risk premiums, from July 2007 to February 2013, including three QE periods. The authors explain three well-known spillover channels of the US unexpected monetary policy which are signaling, portfolio balance, and risk-taking channels, and how these channels affect foreign financial markets. The channels affect the international investors' decisions by changing the portfolio preferences from U.S. assets to international assets which have higher returns. The study is similar to leading studies in the literature but they use different unconventional monetary policy instruments and different country groups. The empirical results show that easing unconventional monetary policy (QE) decreases the interest rate spreads and results in negative VIX shock. The important

result of this study is the effects of U.S. unconventional monetary policies are similar on international financial markets. They also examine whether the effects vary among the countries and within the same country groups and conclude that there is a significant variation in financial spillovers among the EMEs and AEs.

The unconventional monetary policy is a significant source of volatility and increases emerging markets' fragility. In addition to the monetary policy effects, the countries' characteristics are important factors to feel spillover impacts. Georgios Georgiadis (2016) studies a paper for the Working Paper Series of the European Central Bank and specifies the global transmission of US monetary policy in 61 selected countries, in the period between 1999-2009 by using a global VAR model. The writer suggests that there are many country-specific characteristics to explain which country feels more the spillover impacts of US monetary policy shocks. These characteristics are integration and trade openness, financial development, interest rate and the country's other economic structures, and the level of vulnerabilities which includes exchange rate regimes. For instance, if a country has a flexible exchange rate regime, the country can diminish the effects of external shocks with the help of an expenditure-switching channel. Georgios concludes that monetary policy shocks from the US generate quite a big spillover to the rest of the countries and these countries feel larger effects than the United States which is the owner of the shock.

Different channels are transmitting the impact of monetary policy to other countries. Ramos-Francia, M., & García-Verdú, S. (2014) investigate the effect of monetary policy shocks on emerging markets with an empirical analysis for 15 EME countries by running a set of regression for the pre-crisis (Q1 2003 - Q2 2008) and following period (Q3 2008 – Q4 2013). Three channels transfer the monetary policy shocks to

emerging market economies. These channels are; policy rate, exchange rate, and long-run interest rate channels. They determine the importance of these channels may have changed with the third quarter of 2008 at the time of the global financial crisis. Selected countries are special in terms of data availability like which type of exchange rate regime they use, monetary policy regimes, level of financial openness in the markets, and their policy responses. They use the factor augmented vector autoregressive model (FAVAR) for both US and emerging market economies by dividing time series into three groups for both US and EMEs real, financial, and monetary. They conclude the study by explaining the importance of a country's exchange rate regimes to respond to monetary policy shocks and the role of the channels which they explain at the beginning. Rohit, A., & Dash, P. (2019) explain the role of exchange rate regimes to show the monetary policy spillover on AEs and EMEs. In addition to this, they mention the channels which contribute to explaining the degree of spillover effects. The authors include short-run interest rates of 5 advanced and 8 emerging market economies, with the US, by collecting weekly data from 2002-M9 to 2006-M12. They make use of Diebold & Yilmaz (2009) and Wagner's spillover index tables. They find that the advanced economies which use flexible exchange rate regimes can isolate the economy against spillover effects relatively better than the EMEs that are using managed floating exchange rate regimes. They argue that a free-floating exchange rate regime helps to insulate emerging market economies from exposure to external spillovers that they can face. As a result, the importance of the flexible exchange rate regime is to overcome monetary or external shocks' spillover impacts from center economies in the world.

The announcements which is another type of unconventional monetary policy of the US have effects on emerging market countries and also other countries. J. Hausman *et al.* (2011) state the effect of US monetary policy announcements on equity indexes, long and short-term interest rates, and exchange rate regimes in 49 countries. They use two monetary policy surprises; unexpected changes in actual federal funds rate and expected changes in the future path of monetary policy. The period contains from the 4th of February 1994 to the 22nd of March 2005, they use all the FOMC announcements except the 17th of September 2001. The responses of each variable are shown in a table with the announcement dates. They find that the country's financial assets' responses to the announcement are fully different among the countries and these differences are related to countries' exchange rate regimes. The type of exchange rate regime is an important source for the countries to explain how and why they respond to monetary policy shocks in a different path. Interest rates and equity markets in countries that have less flexible exchange rate regimes respond more to monetary policy shocks. Countries that have more flexible exchange rate regimes respond less to shocks or announcements. Gupta *et al.* (2017) examine the spillover effects of the US monetary policy announcements on the emerging market countries' exchange rates, equity prices, and bond yields after the end of the 2008 global crisis. They use the event study method for the 20 largest emerging market countries with available data from the 1st of October 2008 to the 1st of September 2016. During the given period, the monetary policy is considered an unconventional policy, and as an indicator of the policy announcement, they use changes in the 2-year Treasury yield on FOMC announcement days. The announcements always make in the afternoon because financial markets are closed in most of the emerging market countries thus the markets can react to the announcements on the following day. They investigate the effect of both tightening

and easing policy announcements; they result that if there is an unexpected tightening monetary policy announcement, the exchange rate depreciates, equity price decreases and bond yields increase in emerging markets. The easing monetary policy concludes the opposite effects in emerging market economies. They extend the time interval from 1 to 3 days, 5 to 10, and 15 days to see the changes in the effects of announcements over a long period They find the weak spillover effects of US monetary policy announcements on some advanced economies but the results are stronger and economically significant on emerging market countries' financial data.

Orhan, M., & Çelikel, H.İ. (2014) analyze the influence of the Fed's Tapering news on the Fragile Five which is the weakest group among the emerging market economies. They use data, the exchange rate, interest rate, and stock exchange indices for five fragile emerging market countries from 2013 to 2014. They use the tapering announcement as an unconventional monetary policy of the Fed which starts on January 1, 2013 hence the capital flows to the emerging markets reach the highest levels. As we know from the related studies, the impact of the Fed's tapering news depends on the macroeconomic indicators of the countries. To make a clear comparison of the effects of the Fed's unconventional monetary policy between emerging markets and major economies which are globally integrated, they focus on the exchange rate, stock exchange, and bond indexes for Japan, China, Russia, and European Union. After the Tapering news, the exchange rates depreciate in the Fragile Fives and the central banks start to increase the benchmark interest rate and sell the foreign exchange rate until the currency appreciates. In conclusion, the Fragile Five countries are very weak to finance their current account deficit and economic growth, they need to get short-run capital inflows. Thus, the policy suggestion by the authors

is the Fragile Five and other countries which have weak economic fundamentals should make important structural reforms to overcome the negative impact of the monetary policies.

The exchange rate is an important indicator for all countries in the world. In terms of both trade and investment decisions, investors should follow the risk-return movements of big powerful currencies to rebalance their portfolios. Any shocks or crises in the US economy affect other countries directly or indirectly. Different studies focus on the risk and return spillover of currencies after the crises that left a huge trace on the world economy. One of the studies is written by Greenwood-Nimmo, M. *et al.* (2016) it explains the risk and return spillover among the G10 currencies period from January 1999 to October 2014. They use DataStream to get data for a given period. They measure the connectedness by using the VAR models for G10 currencies against the US dollar. The result is that there is a strong spillover for return. The study also examines the effects of the Global Financial Crisis and sovereign debt crisis on the risk-return spillover, the result is that risk-return spillover is increased during fluctuation times. The deterioration in the US economic conditions also rise the exchange rate spillover effects in the FX markets.

The exchange rate contagion risk emerged after the mortgage crisis and creates many important results for emerging market countries. The researchers pay attention to the exchange rate contagion risk after such crises. Loaiza-Maya, R., Gomez-Gonzalez, J.E., & Melo-Velandia, L.F. (2015) examine the level of exchange rate contagion for Latin America countries by using the Regular Vine Copula methodology, and following they use the ARX (p)-GARCH (1,1) model for moments of the variables. They find that there is a strong exchange rate contagion among the four countries. Two

countries which are Argentina and Peru have the weakest exchange rate contagion in the region. Due to historical financial events and the independent exchange rate behavior in Argentina, the contagion risk is weak in this country. The result is different for appreciation and depreciation periods. The exchange rate contagion risk is higher and stronger during the appreciation periods than the depreciation.

Contagion risks during different currency crises are studied by many scholars. A similar study to the previous one is written by Gomez-Gonzalez, J.E. & Rojas-Espinosa, W.E. (2019) to investigate the exchange rate contagion in the Asian Pacific markets (only twelve) for the period from 1991 to 2001 by using the same approach which is R-vine copula. They use the asymmetric DCC-GARCH method. This study exhibits the same results as the literature that contagion risk is different in times of appreciation and depreciation.

Our study is different from the literature, we include 27 emerging market countries and investigate the impact of the US monetary policy on the exchange rate risk and also the connectedness of these countries by using the TVP-VAR method. There are limited studies that explore the exchange rate risk-return connectedness of emerging market countries. The closet study by Naeem *et al.* (2023) focus on the important growth of emerging market currencies in the global foreign exchange rate markets and regarding the vulnerability of emerging markets currencies, they determine the return connectedness of currencies between the year from March 2011 to January 2022 for 16 emerging market economies which are selected according to their importance in the foreign exchange rate markets. They contribute to the literature by applying the asymmetric time-frequency connectedness of exchange rates for 16 emerging market economies and they use the mixed methodologies of Diebold and Yilmaz (2012) and

Barunik and Klernik (2018) due to different approaches that are connectedness for specific time-period and connectedness for frequency. The authors aim to help not only investors but also other market participants to shape their investment strategies by giving a determination of currency contagions within different periods. They define the direction of the spillover and determine the effects of the crisis on currency contagions. The authors specify which countries are net transmitters and which are net receivers of spillovers. They state important crises in the selected countries during the period are; US debt-selling crisis, Chinese market turbulence, the European Debt Crisis, the Russian Ruble Crisis, an economic crisis in Brazil, a monetary crisis in Argentina, and the last crisis that all countries faced is Covid-19. At the end of the study, they find that different currency contagions appear after these crises according to the long-run and short-run analyses. They conclude that the resulting sudden shocks in these countries bring an asymmetry in the exchange rate returns connectedness. After the debt-selling crisis in the US, emerging market currencies appreciate, which means positive contagion in the short-run periods. In contrast, the currency depreciates in emerging markets due to Chinese market turbulence. After the Covid-9 crisis, the exchange rate in emerging markets appreciates in the long run. As a result, four countries are major transmitters while six countries are major receivers in total connectedness analysis. China is a prominent transmitter in all countries in the long run period.

H. Zhou et al. (2022) analyze the effect of US monetary policy on the connectedness of global financial markets. The study includes stock market index weekly data of 48 advanced and emerging market economies, from 2002 to 2021 including the 2008-209 financial crisis and the 2020-2021 COVID-19 pandemic, by dividing the central bank

announcement data into two parts; monetary policy shocks and information shocks. According to the study, policy announcements of the FED affect the global financial markets via two channels, that's why the authors divided announcements into two parts. Both shocks or channels are related to the U.S. key economic indicators thus these channels directly affect the asset prices of the United States trade partners or indirectly affect other trade network countries. While monetary policy shocks are important for bond markets, central bank information shocks are important for equity markets. They conclude that both channels increase global financial connectedness. They use heat maps to show the connectedness from 2002 to 2021 and the result is that during the crisis periods, global financial connectedness increases which is consistent with previous studies. The important result is that FED is a major factor that is driving and transferring the global financial connectedness from AE to EMEs countries.

Chapter 5

DATA AND METHODOLOGY

5.1 Data and Preliminary Analysis

The study aims to investigate the impact of the US monetary policy on the exchange rate risk and connectedness in emerging markets. Within this aim, the study applies weekly percentage changes in exchange rates in 27 emerging market economies, i.e., Argentina (AR), Brazil (BR), China (CN), Czech Republic (CZ), Colombia (CO), Chile (CL), Egypt (EG), Greece (GR), Hungary (HU), South Korea (KR), Malaysia (MY), Mexico (MX), Indonesia (ID), India (IN), Singapore (SG), Saudi Arabia (SA), South Africa (ZA), Pakistan (PK), Poland (PL), Philippines (PH), Peru (PE), Russia (RU), Taiwan (TW), Turkey (TR), Thailand (TH), United Arab Emirates (AE) and Qatar (QA). The currency names of these countries are given in Appendix A. We include the Federal Funds Rate, Forward Guidance, and Large-Scale Asset Purchases as the US. monetary policy factors which are given in Appendix B. The dataset is taken from DataStream for the period from July 1992 to May 2023, and we used R-Studio for estimation. As we can see in Table 1, there are some descriptive statistics and we need to analyze them to establish a DY model which is based on the TVP-VAR method. For the mean, except Singapore and China, all other countries have positive means and positive returns. According to the Jarque-Bera normality test, the whole returns do not follow the normal distribution therefore we reject the null hypothesis. We use Elliot, Rothenberg, and Stock (ERS)'s unit root test for testing the stationary conditions of the variables.

After analyzing some descriptive statistics, we can determine the correlation matrix of emerging market currencies. Figure 2 reveals the negative and positive correlations for each currency. The strong and positive significant correlation is noticed in pairs HU-CZ (0.586) followed by GR-CZ (0.560) and PL-GR (0.498) because of the proximity of countries and sharing the same country zone, Europe. GR-HU (0.495), PL-HU (0.482), and PL-HU (0.462) are other significant positive correlations. There are negative correlations such as CH-AE (-0.017) and SA-PA (-0.06). Qatar (QA) has a negative correlation with other countries except for Argentina and the Arab Emirates. None of the pair country's returns is close to one means that the risk spread of the exchange rate market has little effect on other markets. The related tables are on the next page.

Table 1: Descriptive Statistics

	Mean	Std. Dev.	Variance	Skewness	Kurtosis	JB	ERS	Q(20)	Q2(20)
AR	0.315***	1.712	2.931***	5.132***	49.285***	170225.348***	-11.352***	138.029***	339.613***
BR	0.538***	2.719	7.393***	1.428***	6.065***	3018.958***	-6.198***	1641.809	2009.690***
CN	-0.005	0.328	0.108***	0.593***	10.090***	6932.403***	-13.220***	121.365***	562.792***
CZ	0.000	1.583	2.508***	0.267***	1.743***	223.121***	-17.362***	9.916	331.973***
CO	0.126***	1.601	2.566***	0.637***	5.900***	2446.948***	-12.375***	19.436**	198.450***
CL	0.057	1.453	2.112***	0.220***	5.696***	2192.306***	-8.891***	21.528***	309.696***
EG	0.077***	0.746	0.558***	2.309***	68.416***	315819.200***	-17.046***	122.338***	341.504***
GR	0.041	1.080	1.658***	0.666***	6.170***	2676.018***	-11.653***	10.029	38.358***
HU	0.11⁰**	1.809	3.274***	0.508***	3.017***	680.897***	-14.972***	9.787	461.668***
KR	0.048	1.727	2.983***	5.251***	110.438***	826605.074***	-16.555***	99.239***	166.497***
MY	0.040	1.125	1.266***	0.507***	30.684***	63306.823***	-15.154***	88.165***	1485.954***
MX	0.125***	1.862	3.468***	6.201***	113.197***	870970.572***	-16.703***	65.059***	47.604***
ID	0.153**	2.989	8.935***	6.272***	150.394***	1529775.052***	-16.519***	277.094***	420.572***
IN	0.064***	0.803	0.646***	0.100*	6.389***	2744.395***	-3.348***	35.168***	211.880***
SG	-0.009	0.738	0.546***	-0.124**	7.529***	3811.282***	-17.175***	21.623***	447.655***
SA	0.000	0.031	0.001***	8.303***	230.787***	3595989.750***	-22.342***	188.869***	92.197***
ZA	0.144***	2.103	4.423***	0.535***	3.537***	916.948***	-14.831***	14.901	376.711***
PK	0.156***	1.054	1.113***	3.829***	37.110***	96436.658***	-15.886***	50.242***	66.229***
PL	0.064	1.799	3.237***	-0.070	19.125***	24567.393***	-15.503***	15.340	319.415***
PH	0.054**	1.026	1.053***	0.936***	12.501***	10731.924***	-16.578***	55.456***	1231.606***
PE	0.073***	0.760	0.579***	0.564***	7.030***	3405.101***	-3.159***	108.589***	556.129***
RU	0.477***	3.094	9.576***	7.044***	96.826***	643036.446***	-3.219***	357.036***	224.151***
TW	0.016	0.614	0.378***	0.326***	5.787***	2277.823***	-8.017***	43.670***	332.757***

TR	0.500***	2.592	6.719***	-0.513***	54.687***	200942.944***	-14.330***	88.917***	283.293***
TH	0.016	1.131	1.280***	0.492***	18.642***	23407.359***	-16.346***	88.868***	1519.792***
AE	0.000	0.000	0.000***	-0.081	121.952***	998918.085***	-26.340***	293.589***	494.664***
QA	0.002	0.207	0.043***	0.028	40.087***	107935.945***	-21.004***	292.461***	1010.195***

Note: * Indicates significance at a 10% significance level, ** indicates significance at a 5% significance level, and *** indicates significance at a 1% significance level.

Kendall	AR	BR	CN	CZ	CO	CL	EG	GR	HU	KR	MY	MX	ID	IN	SG	SA	ZA	PK	PL	PH	PE	RU	TW	TR	TH	AE	QA
AR	1.000***	0.075***	0.02	0.021	0.064***	0.040**	0.041**	0.011	0.027	0.026	0.067***	0.065***	0.066***	0.069***	0.036**	-0.012	0.043***	0.042**	0.039**	0.034**	0.047***	0.002	0.032	0.011	0.026	-0.003	0.014
BR	0.075***	1.000***	0.107***	0.154***	0.184***	0.205***	0.045***	0.123***	0.191***	0.179***	0.168***	0.256***	0.162***	0.182***	0.183***	0.007	0.236***	0.035**	0.201***	0.149***	0.178***	0.145***	0.165***	0.232***	0.151***	0.014	-0.024
CN	0.020	0.107***	1.000***	0.165***	0.094***	0.094***	0.038*	0.156***	0.150***	0.187***	0.236***	0.082***	0.142***	0.126***	0.226***	0.049***	0.140***	0.018	0.176***	0.123***	0.097***	0.100***	0.207***	0.110***	0.154***	-0.017	-0.010
CZ	0.021	0.154***	0.165***	1.000***	0.096***	0.128***	0.047***	0.560***	0.150***	0.187***	0.209***	0.138***	0.150***	0.156***	0.405***	0.033**	0.276***	0.013	0.469***	0.145***	0.106***	0.131***	0.260***	0.245***	0.236***	-0.002	-0.023
CO	0.064***	0.184***	0.094***	0.096***	1.000***	0.262***	0.054***	0.096***	0.130***	0.157***	0.205***	0.202***	0.154***	0.124***	0.139***	0.038**	0.155***	0.027	0.181***	0.141***	0.179***	0.218***	0.138***	0.127***	0.126***	0.018	-0.020
CL	0.040**	0.205***	0.094***	0.128***	0.262***	1.000***	0.014	0.135***	0.151***	0.175***	0.190***	0.186***	0.168***	0.141***	0.185***	0.045***	0.191***	0.033**	0.230***	0.140***	0.169***	0.168***	0.162***	0.150***	0.176***	-0.006	-0.034**
EG	0.041**	0.043***	0.038**	0.047***	0.054***	0.014	1.000***	0.057***	0.039**	0.038**	0.046***	0.023	0.044***	0.036**	0.047***	0.004	0.047***	0.031	0.078***	0.043**	0.035**	0.030	0.066***	0.051***	0.045***	0.039**	-0.002
GR	0.011	0.123***	0.156***	0.560***	0.096***	0.135***	0.057***	1.000***	0.495***	0.196***	0.210***	0.072***	0.146***	0.148***	0.354***	0.026	0.219***	0.020	0.498***	0.142***	0.087***	0.156***	0.247***	0.232***	0.231***	0.017	-0.047***
HU	0.027	0.191***	0.150***	0.586***	0.130***	0.151***	0.039**	0.495***	1.000***	0.235***	0.211***	0.173***	0.151***	0.199***	0.384***	0.038**	0.304***	0.032	0.482***	0.159***	0.115***	0.144***	0.261***	0.294***	0.244***	0.009	-0.050***
KR	0.026	0.179***	0.187***	0.215***	0.157***	0.175***	0.038**	0.196***	0.235***	1.000***	0.270***	0.203***	0.234***	0.259***	0.403***	0.000	0.264***	0.030	0.257***	0.285***	0.118***	0.140***	0.413***	0.189***	0.307***	0.013	-0.019
MY	0.067***	0.168***	0.236***	0.209***	0.205***	0.190***	0.046***	0.210***	0.211***	0.270***	1.000***	0.190***	0.274***	0.225***	0.387***	0.022	0.213***	0.024	0.261***	0.250***	0.137***	0.152***	0.288***	0.176***	0.257***	0.032	-0.014
MX	0.065***	0.256***	0.082***	0.138***	0.202***	0.186***	0.023	0.072***	0.173***	0.203***	0.190***	1.000***	0.135***	0.181***	0.192***	0.011	0.273***	0.020	0.182***	0.153***	0.194***	0.128***	0.168***	0.177***	0.139***	0.013	-0.028
ID	0.066***	0.162***	0.142***	0.150***	0.154***	0.168***	0.044***	0.146***	0.151***	0.234***	0.274***	0.135***	1.000***	0.188***	0.300***	0.021	0.188***	0.034**	0.197***	0.247***	0.098***	0.118***	0.212***	0.150***	0.281***	0.003	-0.020
IN	0.069***	0.182***	0.126***	0.156***	0.124***	0.141***	0.036**	0.148***	0.199***	0.259***	0.225***	0.181***	0.188***	1.000***	0.234***	-0.020	0.212***	0.020	0.209***	0.226***	0.112***	0.101***	0.243***	0.204***	0.220***	0.009	-0.017
SG	0.036**	0.183***	0.226***	0.405***	0.139***	0.185***	0.047***	0.354***	0.384***	0.403***	0.387***	0.192***	0.300***	0.234***	1.000***	0.021	0.326***	0.030	0.335***	0.260***	0.136***	0.133***	0.389***	0.237***	0.387***	0.013	-0.028
SA	-0.012	0.007	0.049***	0.033**	0.038**	0.045***	0.004	0.026	0.038**	0.000	0.022	0.011	0.021	-0.020	0.021	1.000***	0.019	-0.006	0.054***	0.027	-0.006	0.049***	0.021	-0.018	0.036**	0.016	0.021
ZA	0.043***	0.236***	0.140***	0.276***	0.155***	0.191***	0.047***	0.219***	0.304***	0.264***	0.213***	0.273***	0.188***	0.212***	0.326***	0.019	1.000***	0.015	0.275***	0.173***	0.146***	0.144***	0.238***	0.282***	0.218***	-0.009	-0.034**
PK	0.042**	0.035**	0.018	0.013	0.027	0.033**	0.031	0.020	0.032	0.030	0.024	0.020	0.034**	0.020	0.030	-0.006	0.015	1.000***	0.018	0.031	0.013	-0.019	0.025	0.036**	0.040**	-0.007	-0.002
PL	0.039**	0.201***	0.176***	0.469***	0.181***	0.230***	0.078***	0.498***	0.482***	0.257***	0.261***	0.182***	0.197***	0.209***	0.335***	0.054***	0.275***	0.018	1.000***	0.193***	0.160***	0.208***	0.268***	0.248***	0.245***	0.000	-0.055***
PH	0.034**	0.149***	0.123***	0.145***	0.141***	0.140***	0.043**	0.142***	0.159***	0.285***	0.250***	0.153***	0.247***	0.226***	0.260***	0.027	0.173***	0.031	0.193***	1.000***	0.087***	0.086***	0.220***	0.163***	0.266***	-0.001	-0.009
PE	0.047***	0.178***	0.097***	0.106***	0.179***	0.169***	0.035**	0.087***	0.115***	0.118***	0.137***	0.194***	0.098***	0.112***	0.136***	-0.006	0.146***	0.013	0.160***	0.087***	1.000***	0.118***	0.117***	0.105***	0.113***	0.001	-0.045***
RU	0.002	0.145***	0.100***	0.131***	0.218***	0.168***	0.030	0.156***	0.144***	0.140***	0.152***	0.128***	0.118***	0.101***	0.133***	0.049***	0.144***	-0.019	0.208***	0.086***	0.118***	1.000***	0.124***	0.126***	0.120***	-0.002	0.004
TW	0.032	0.165***	0.207***	0.260***	0.138***	0.162***	0.066***	0.247***	0.261***	0.413***	0.288***	0.168***	0.212***	0.243***	0.389***	0.021	0.238***	0.025	0.268***	0.220***	0.117***	0.124***	1.000***	0.165***	0.288***	-0.011	-0.012
TR	0.011	0.232***	0.110***	0.245***	0.150***	0.150***	0.051***	0.232***	0.294***	0.189***	0.176***	0.177***	0.150***	0.204***	0.237***	-0.018	0.282***	0.036**	0.248***	0.163***	0.105***	0.126***	0.165***	1.000***	0.181***	0.006	-0.033**
TH	0.026	0.151***	0.154***	0.236***	0.126***	0.176***	0.045***	0.231***	0.244***	0.307***	0.257***	0.139***	0.281***	0.220***	0.387***	0.036**	0.218***	0.040**	0.245***	0.266***	0.113***	0.120***	0.288***	0.181***	1.000***	0.016	-0.035**
AE	-0.003	0.014	-0.017	-0.002	0.018	-0.006	0.039**	0.017	0.009	0.013	0.032	0.013	0.003	0.009	0.013	0.016	-0.009	-0.007	0.000	-0.001	0.001	-0.002	-0.011	0.006	0.016	1.000***	0.063***
QA	0.014	-0.024	-0.010	-0.023	-0.020	-0.034**	-0.002	-0.047***	-0.050***	-0.019	-0.014	-0.028	-0.020	-0.017	-0.028	0.021	-0.034**	-0.002	-0.055***	-0.009	-0.045***	0.004	-0.012	-0.033**	-0.035**	0.063***	1.000***

Figure 1: Correlation Matrix of Emerging Market Currencies
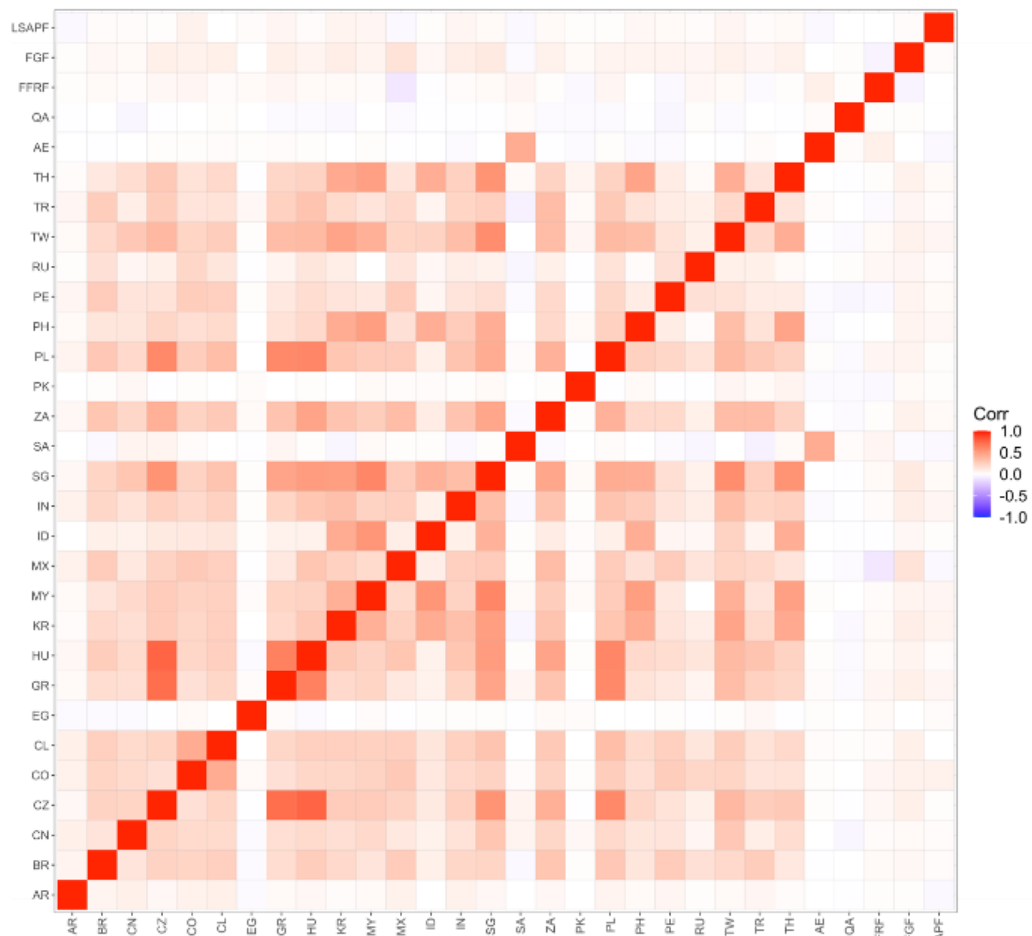
Figure 2: Correlation Heat Map of Emerging Market's Currencies

The correlation heat map is a tool that shows the correlation among all emerging market economies with color codes such as red and blue. The dark red shows the strong correlations between different variables. For instance, we can interpret HU- CZ as a strong correlation. From red to white, the level of correlation decreases. When it reached the blue color, it means that there is a negative correlation among the variables (Figure 2).
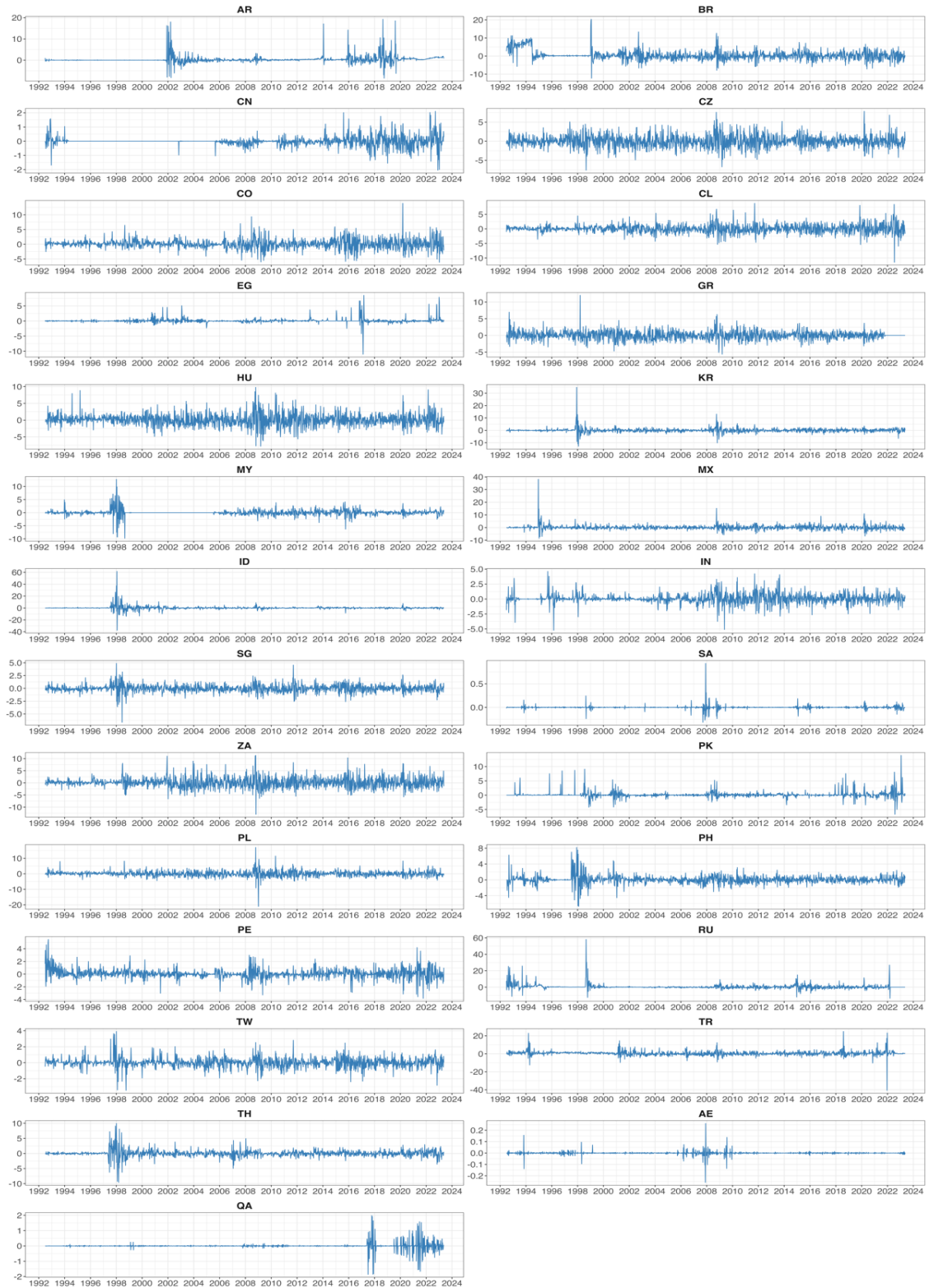
Figure 3: Currency Returns Series Over the Period from 07/1992 to 05/2023

5.2 Methodology

Diebold & Yılmaz's (2009:2012:2014) connectedness approach is one of the most famous econometric analyses among researchers and scholars in recent years. This method is successful to estimate interconnectedness between different variables thence scholars and researchers can make implications on the return spillover of different financial assets. The connectedness approach provides static and dynamic time series network assessments to participants in the financial market. A Vector Autoregressive (VAR) model is adopted by the static approach and the dynamic method adopts a rolling-window Vector Autoregressive (VAR).

In this study, we use a Time-Varying Parameter Vector Autoregression which is found by Antonakakis et al. (2020). They aimed to prevent data loss by replacing the rolling-window VAR. Bouri et al. (2021) result that using the TVP-VAR connectedness approach has some advantages; the outlier insensitivity caused by the underlying Kalman filter, choosing the rolling-window size is not necessary, thanks to the TVP-VAR connectedness, there is no loss of data and lastly, this approach is also used for low-frequency dataset.

We estimate the TVP-VAR model to study time-varying exchange rate risk among the emerging market's exchange rate market. To get the advantages of the model, we follow Bouri et al. (2021)'s investigation that TVP-VAR is determined by Bayesian Information Criteria (BIC) and it can be described as follow:

$$X_t = \beta_t X_{t-1} + \gamma_t, \gamma_t \sim N(0, D_t) \tag{1}$$

From Equation (1); X_t, X_{t-1}, and γ_t are k x 1-dimensional vectors, β_t and D_t are dimensional matrices.

$$vec(\beta_t) = vec(\beta_{t-1}) + \mu_t, \quad \mu_t \sim N(0, P_t) \tag{2}$$

From Equation (2); $vec\beta_t$ and μ_t are $k^2 \times 1$ dimensional vectors. P_t is a time-varying

variance-covariance matrix with the dimension of $k^2 \times k^2$.

The connectedness approach of Diebold & Yılmaz is based on the Generalized

Forecast Error Variance Decomposition (GFEVD) analysis and there is a need to

transform TVP-VAR to TVP-MA according to the World representation theorem as

below:

$$X_t = \sum_{i=1}^{p} B_{it} X_{t-i} + \gamma_t = \sum_{j=0}^{\infty} S_{jt}\, \gamma_{t-j} \tag{3}$$

We can estimate a pairwise directional connectedness by normalizing the GFEVD and

$\sigma_{ij,t}^{f}$ that shows how many variables j can affect the i from the point of its forecast

error variance share. To show the effect of a shock in the variable j on a variable i,

that is known as the pairwise directional connectedness from j to i can be computed

as below:

$$\sigma_{ij,t}^{f}(H) = \frac{D_{ij,t}^{-1} \sum_{t=1}^{H-1} (l' S_t l j)^2}{\sum_{j=1}^{k} \sum_{t=1}^{H-1} l_i D_t S_t' l_i} \tag{4}$$

$$\sigma_{ij,t}^{f'}(H) = \frac{\sigma_{ij,t}^{f}(H)}{\sum_{ij,t}^{k} \sigma_{ij,t}^{f}(H)} \tag{5}$$

From Equations (4) and (5); if $\sum_{j,t}^{k} \sigma_{ij,t}^{f'}(H) = 1$, $\sum_{ij,t}^{k} \sigma_{ij,t}^{f'}(H) = k$, and l_i, it can be

said that there will be a close consonance of a chosen vector with unity on the ith

position and otherwise it will be zero.

We can calculate the connectedness measure according to Diebold & Yılmaz (2012:

2014) via Generalized Forecast Error Variance Decomposition as follow:

$$TO_{jt} = \sum_{i=1, i\neq j}^{k} \sigma_{ij,t}^{f'}(H) \tag{6}$$

$$FROM_{jt} = \Sigma_{i=1,i \neq j}^{k} \sigma_{ji,t}^{f'}(H) \tag{7}$$

$$NET_{jt} = TO_{jt} - FROM_{jt} \tag{8}$$

$$TCI_t = k^{-1} \Sigma_{j=1}^{k} TO_{jt} = k^{-1} \Sigma_{j=1}^{k} FROM_{jt} \tag{9}$$

$$NPDC_{ij,t} = \sigma_{ij,t}^{f'}(H) - \sigma_{ji,t}^{f'}(H) \tag{10}$$

Equation (6) represents the total directional connectedness to others via the total effect of a shock in j on all other variables. Equation (7) represents the total directional connectedness from others via the total effect of other variables on the variable j. The other equation shows the net total directional connectedness explaining which variable is the net transmitter or receiver of shocks. We can compute a variable as a net transmitter if the NET > 0 or if the NET<0 variable is the net receiver. Equation (9) shows the total connectedness index which exhibits the average effect of a variable on other variables. We result that if TCI is high, there is a significantly interconnected network. As a result market risk is higher and the shock in j will affect the other variables or vice versa. The last equation shows the Net Pairwise Directional Connectedness; it gives information about the relationship between j and i, it demonstrates how the variable i affects the variable j. We can conclude that if NPDC>0, the variable j derives the variable i or vice versa is correct.

5.3 Empirical Findings

In this part, we indicate linear VAR and TVP-VAR model connectedness results and determine the transmitter and receiver countries from the results. From Table 2, we can see the Linear VAR Model Connectedness results for all countries after the monetary policy shocks in the US. Some of the countries are affected more than others due to trade relations arising from geopolitical proximity. For instance, when we analyze Argentina; the connectedness from Mexico to Argentina is the highest one

among the other countries. This result shows that; Argentina is affected more by fluctuations in Mexica's economy. Another example is the connectedness between the Arab Emirates and Saudi Arabia. These two countries have a big and strong connectedness from the Arab Emirates to Saudi Arabia result and it's around 18.61% which means there is a significant transmission from AE exchange rate risk to the SA foreign exchange market. The related tables are given in the next pages.

5.3.1 Connectedness Analysis

After estimating the TVP-VAR model for emerging market countries' exchange rate data we can present the estimated return measures of countries. Table 3 exhibits the TVP-VAR Model Connectedness results. Among all countries, the FX market in Greek is affected more by two different countries. Greek receives the highest share of the exchange rate risk from the Czech Republic which is 13.24%.

The second FX market, affects the Greek exchange market more, Hungary which contributes about 11.07% to the oscillations in the Greek exchange rate market. On the contrary, Hungary is affected by the Czech Republic and Greek with significant percentages that are orderly 12.53% and 10.55%. As a result, from Table 2, we can evaluate that the Czech Republic, Hungary, Greek, and Singapore are the strongest transmitters of the exchange rate risk. We can find other transmitter countries by investigating the table but the risk transmission is low for these countries. For example; Turkey, South Africa, and Brazil are transmitter countries with low levels of connectedness. The related tables are given in the next pages.

Table 2: Linear VAR Model Connectedness Table

	AR	BR	CN	CZ	CO	CL	EG	GR	HU	KR	MY	MX	ID	IN
AR	93.89	0.46	0.63	0.19	0.43	0.43	0.12	0.13	0.2	0.1	0.12	0.71	0.01	0.7
BR	0.24	52.43	0.98	2.55	2.08	2.83	0.03	1.55	3.45	2.1	1.08	3.81	0.27	2.35
CN	0.38	1.26	57.85	2.91	2.42	2.38	0.06	1.69	2.42	1.78	2.38	0.87	0.23	1.36
CZ	0.05	1.46	1.28	26.18	0.76	1.36	0.06	13.86	15.31	2	2.17	1.37	0.4	1.48
CO	0.21	2.53	1.87	1.68	47.27	8.04	0.14	1.24	2.51	2.37	2.52	4.08	0.6	2.32
CL	0.27	3.42	1.49	2.77	7.13	42.01	0.01	1.8	3.38	2.94	2.55	3.24	0.59	2.71
EG	0.47	0.03	0.12	0.03	0.45	0.06	97.42	0.11	0.02	0.02	0.07	0.02	0.04	0.07
GR	0.03	1.1	0.92	16.89	0.76	1.2	0.07	31.29	13.24	1.14	1.52	0.45	0.13	1.4
HU	0.05	1.96	1.05	15.35	1.26	1.76	0.01	10.86	26.25	2.17	1.57	2.3	0.21	2.3
KR	0.02	1.48	0.94	2.69	1.48	1.95	0	1.21	2.78	32.75	5.25	1.88	6.45	3.71
MY	0.02	0.78	1.29	2.57	1.65	1.87	0.03	1.52	1.88	5.13	31.67	1.28	9.02	2
MX	0.29	3.92	0.76	2.47	3.84	3.25	0.01	0.69	4.23	2.71	1.95	47.78	0.48	2.92
ID	0.01	0.35	0.21	0.68	0.58	0.62	0.03	0.21	0.47	8.04	13.24	0.45	45.71	0.59
IN	0.17	2.24	0.96	2.69	1.66	2.35	0.04	2.02	4.03	5.24	2.62	2.74	0.35	43.94
SG	0.03	1.27	2.08	7.09	1.39	2.27	0	5.1	6.07	5.69	8.35	1.69	3.65	2.61
SA	0.01	0.07	0.17	0.29	0.07	0.06	0.02	0.19	0.03	0.22	0.09	0.08	0.01	0.1
ZA	0.11	3.84	1.71	5.67	1.92	2.83	0.05	3.28	7.33	3.36	2.39	4.13	0.42	3.16

PK	PL	PH	PE	RU	TW	TR	TH	AE	QA	TO	Inc. Own	NET
0	0.1	0.07	0.17	0.02	0.03	0.13	0.01	0.01	0.06	2.04	96.84	-1.16
0.36	2.75	0.88	4.35	2.29	1.38	4	0.66	0.02	0.02	29.7	95.29	8.03
0.56	1.1	0.69	1.18	0.07	2.56	0.49	1.11	0.08	0.01	16.82	82.13	-0.04
0.07	10.79	1.59	1.5	0.91	4.49	3.73	2.76	0.08	0.05	64.07	118.66	-6.97
0	1.81	1.11	3.95	3.65	1.44	1.16	0.8	0.01	0.37	29.23	89.46	-0.6
0.24	3.02	1.42	3.43	0.92	2.06	1.18	1.46	0.14	0.14	32.74	89.27	1.44
0.06	0.01	0.04	0.13	0.02	0.01	0.14	0.06	0	0.01	0.81	98.59	-2.06
0.02	9.85	0.88	0.93	0.25	3.79	3.21	1.45	0.11	0.12	45.77	97.36	-14.58
0.07	11.05	1.56	1.88	1.59	4.26	5.09	2.13	0.06	0.01	65.87	121.33	-0.49
0.16	2.45	7.74	1.2	0.72	7.19	1.85	7.41	0.04	0.05	51.14	106.57	5.57
0.24	2.06	9.59	1.07	0.02	5.38	1.19	9.06	0.04	0.02	53.02	108.21	-1.9
0.55	2.17	1.1	4.42	2.18	1.55	2.24	0.67	0.02	0.04	30.5	91.81	3.91
0.09	0.16	6.94	0.21	0.08	1.75	0.26	6.62	0.01	0.01	27.01	84.71	-16.37
0.29	2.79	2.91	1.26	0.6	3.61	2.75	1.96	0.18	0.06	32.01	90.14	5.83

Table 2: Linear VAR Model Connectedness Table

	SG	SA	ZA	PK	PL	PH	PE	RU	TW	TR	TH	AE	QA	From
AR	0.15	0.02	0.26	0.2	0.34	0.16	0.27	0	0.18	0.23	0.04	0.01	0.02	3.2
BR	2.61	0.06	5.38	0.01	4.35	1.01	3	1.07	1.99	3.87	0.86	0.02	0.02	21.67
CN	5.47	0.21	3.06	0.07	2.35	1.09	1.35	0.35	5.22	0.62	1.86	0.05	0.32	16.86
CZ	8.27	0.1	4.43	0.04	9.71	1.1	0.62	0.22	3.71	1.87	2.05	0.08	0.04	71.04
CO	3.35	0.03	3.32	0.01	3.15	1.67	3.6	1.94	2.74	1.4	1.31	0.09	0.01	29.83
CL	4.71	0.03	4.72	0.03	4.66	1.75	2.71	0.54	3.37	1.3	1.81	0.07	0.02	31.3
EG	0.02	0.02	0.17	0.08	0.09	0.03	0.14	0	0.05	0.41	0.04	0.02	0	2.88
GR	7.14	0.11	3.14	0.03	10.91	0.72	0.46	0.09	3.83	1.98	1.37	0.05	0.03	60.35
HU	7.1	0.01	5.71	0.04	10.05	1.05	0.82	0.44	3.51	2.57	1.48	0.07	0.05	66.36
KR	8.16	0.13	3.29	0.05	2.84	6.44	0.65	0.22	7.61	1.16	6.82	0.01	0.03	45.57
MY	11.6	0.07	2.33	0.08	2.28	8.03	0.54	0	5.49	0.78	8.03	0.05	0	54.93
MX	3.55	0.02	5.85	0.12	3.66	1.41	3.53	0.94	2.44	2.07	0.96	0.03	0.14	26.59
ID	7.22	0.02	0.7	0.01	0.27	8.8	0.17	0.03	2.43	0.38	8.72	0.04	0	43.39
IN	5.25	0.04	4.37	0.01	4.34	3.42	0.92	0.35	5.33	2.61	2.22	0.04	0.03	26.17
SG	22.46	0.02	4.76	0.04	4.41	3.93	0.78	0.13	7.85	1.45	6.87	0	0.02	67.75
SA	0.07	79.11	0.08	0.05	0.04	0.06	0.06	0.08	0.01	0.27	0.1	18.61	0.06	25.27

	ZA	PK	PL	PH	PE	RU	TW	TR	TH	AE	QA	TO	Inc. Own	NET
SG	7.11	0.17	5.62	6.64	2.35	0.56	10.86	3.38	10.69	0.14	0.02	84.66	144.67	16.91
SA	0.03	0.01	0.07	0.04	0.05	0.33	0.04	0.19	0.04	13.82	0.04	10.77	94.66	-14.5
ZA	33.54	0.32	4.76	1.62	2.95	1.32	3.92	6.4	1.92	0.07	0.01	51.85	108.38	12.3
PK	0.04	95.2	0.07	0.04	0.18	0.02	0.13	0.06	0.13	0.01	0.14	1.16	96.88	-3.3
PL	5.52	0.11	28.25	2.23	2.74	1.63	3.9	4.12	2.02	0.04	0.17	59.53	114.19	5.93
PH	1.4	0.17	1.66	38.35	0.84	0.17	3.6	1.24	7.72	0.02	0.02	39.83	95.85	0.86
PE	1.5	0.05	1.35	0.51	60.1	2.32	0.66	0.5	0.42	0.09	0.74	19.22	87.84	-0.48
RU	0.35	0.03	0.62	0.02	1.67	78.93	0.21	0.33	0.05	0.01	0.02	6.75	88.67	-5.65
TW	4.25	0.43	3.65	4.55	1.62	0.89	30.55	2.12	6.01	0.09	0.01	54.99	109.92	9.51
TR	4.16	0.18	2.24	0.9	0.58	0.34	1.23	53.12	0.81	0.08	0	23.2	86.61	3.55
TH	1.79	0.37	1.54	8.56	0.75	0.1	5.4	1.12	34.02	0.01	0	44.46	98.2	-0.46
AE	0.01	0.02	0.02	0.01	0.11	0.03	0.02	0.02	0.01	84.79	0.05	13.54	104.33	-3.56
QA	0.1	0.24	0.02	0.02	0.36	0.04	0.01	0.01	0.01	0.03	97.82	1.12	99.44	-1.7
From	39.55	4.46	53.6	38.97	19.71	12.4	45.48	19.65	44.92	17.1	2.82	891.81	TCI	33.03

Table 3: TVP-VAR Model Connectedness Table

	AR	BR	CN	CZ	CO	CL	EG	GR	HU	KR	MY	MX	ID	IN
AR	51.64	2.62	3.05	0.64	1.63	1.39	3.03	0.63	0.85	0.62	2.13	1.07	1.46	1.28
BR	3.98	37.51	1.73	1.95	3.43	4.3	1.97	1.68	2.27	2.14	1.96	4.72	3.31	2.53
CN	2.38	1.48	48.1	1.26	1.37	1.3	1.31	1.44	1.1	1.73	2.87	0.98	1.55	1.48
CZ	1.48	2.5	2.27	22.98	1.76	2.33	1.63	13.24	12.53	3.28	2.77	2.45	1.99	2.3
CO	1.69	2.4	1.29	0.97	41.13	4.83	1.48	1.03	1.03	1.64	2.5	2.94	2.12	1.59
CL	1.5	2.95	1.44	1.2	5.14	38.14	1.14	1.38	1.36	1.81	2.28	2.97	2.25	1.82
EG	2.33	0.87	0.9	0.6	1.14	0.64	59.57	0.59	0.51	0.65	0.72	0.66	0.8	0.8
GR	1.54	1.89	2.49	12.83	1.66	2.3	1.36	24.52	10.55	2.73	2.78	1.62	1.79	2.14
HU	1.83	3.13	1.99	12.41	1.87	2.44	1.5	11.07	23.98	2.84	2.32	3.29	1.98	2.82
KR	1.28	2.7	2.58	2.58	2.41	2.73	1.56	2.42	2.46	29.95	3.78	2.99	4.52	4.17
MY	2.39	2.2	3.96	2.39	3.44	3.22	1.83	2.45	2.07	3.74	29.65	2.64	6.81	2.96
MX	1.77	5.13	1.13	1.91	3.62	3.32	1.33	1.46	2.48	2.7	2.4	39.31	2.31	2.85
ID	2.07	2.79	1.82	1.3	2.5	2.53	1.37	1.26	1.23	3.97	5.4	1.85	34.51	2.92
IN	1.86	2.38	1.61	1.41	2.04	2.05	1.69	1.52	1.85	3.19	2.39	2.42	3.22	40.62
SG	0.5	1.99	1.82	6.45	1.28	1.79	0.55	5.58	5.34	6.21	6.05	2.38	3.92	2.24
SA	1.71	1.36	1.39	1.49	0.98	0.87	1.39	1.42	1.69	1.63	1.41	1.3	1.27	1.1
ZA	1.28	3.62	1.4	4.94	1.67	2.33	0.94	3.59	5.16	3.32	2.58	4.37	2.19	2.27

	NPT	NET	Inc.Own	TO	QA	AE	TH	TR	TW	RU	PE	PH	PL	PK
AR	7	-8.28	91.72	40.08	2.52	3.16	0.83	2.28	0.73	1.67	1.75	1.04	0.77	1.42
BR	14	4.75	104.75	67.24	1.25	1.15	1.95	4.57	1.88	3.17	3.76	2.34	2.49	1.73
CN	5	-11.82	88.18	40.08	1.67	1.54	1.57	0.95	2.16	1.84	1.42	1.56	1.22	1.28
CZ	25	19.23	119.23	96.25	1.09	1.2	3.92	4.33	4.03	2.95	2.39	1.98	9.62	1.31
CO	7	-10.72	89.28	48.15	1.13	1.32	1.36	1.52	1.53	3.96	2.99	1.94	1.55	1.44
CL	9	-11.03	88.97	50.84	1.09	1.34	1.93	1.75	1.59	2.64	2.72	1.76	2.32	1.47
EG	3	-16.71	83.29	23.72	1.04	1.23	0.67	0.92	0.88	1.08	1.44	0.81	0.63	0.96
GR	23	12.82	112.82	88.3	1.36	1.26	3.65	4.1	3.97	3.02	1.99	1.73	9.78	1.18
HU	24	19.81	119.81	95.83	1.52	1.54	3.8	5.37	3.63	2.95	2.5	1.93	9.56	1.34
KR	21	9.63	109.63	79.68	1.39	1.71	5.91	2.56	7.56	2.4	1.98	4.72	2.8	1.29
MY	19	10.78	110.78	81.14	1.88	2.64	5.17	2.2	4.02	3.76	2.7	4.42	2.78	1.44
MX	15	2.27	102.27	62.96	1.18	1.21	2.01	3.55	2.03	2.44	4.07	2.25	2.37	1.37
ID	11	-5.24	94.76	60.25	1.64	2.22	3.77	1.76	2.3	1.62	1.52	3.9	1.64	1.48
IN	13	-4.88	95.12	54.5	1.02	1.41	2.82	2.57	2.92	1.88	1.79	3.58	1.78	1.49

Table 3: TVP-VAR Model Connectedness Table

	SG	SA	ZA	PK	PL	PH	PE	RU	TW	TR	TH	AE	QA	From
AR	1.48	0.91	1.66	1.17	1.88	1.64	1.63	1.95	1.48	3.58	1.5	1.91	1.46	48.36
BR	3.07	0.79	4.12	0.83	3.06	1.96	2.93	2.11	2.13	4.95	2.21	0.73	0.57	62.49
CN	3.62	1.77	1.92	0.86	2.32	1.73	1.24	2.18	3.17	1.57	2.14	1.23	1.88	51.9
CZ	6.88	0.64	3.8	0.45	9.01	1.28	1.24	1.48	3.05	3.59	3.09	0.64	0.43	77.02
CO	2.5	0.8	2.68	1	2.59	2.41	3.27	3.64	2.28	2.42	1.76	0.76	0.76	58.87
CL	3.26	0.57	3.73	0.84	3.73	2.12	2.88	2.28	2.4	2.38	2.85	0.77	0.69	61.86
EG	1.56	1.34	1.72	1.1	1.73	1.52	1.27	1.84	1.57	1.95	1.24	1.39	1.01	40.43
GR	6	0.76	3.02	0.49	9.69	1.14	1.04	1.83	3.1	3.77	3.06	0.9	0.49	75.48
HU	5.77	0.72	4.16	0.44	9.04	1.39	1.33	1.5	2.77	4.51	3.02	0.67	0.41	76.02
KR	7.67	0.68	3.2	0.55	3.17	3.96	1.28	1.59	7.32	2.35	5.86	0.8	0.57	70.05
MY	7.53	1	2.59	0.68	3.33	3.68	1.83	2.7	3.89	2.16	4.69	1.04	0.94	70.35
MX	3.34	0.97	4.78	0.91	2.97	2.12	3.56	1.62	2.23	3.93	2.06	0.9	0.7	60.69
ID	6.28	0.66	2.79	0.63	2.39	4.56	1.29	1.37	2.71	2.5	4.84	0.66	0.67	65.49
IN	3.85	0.64	3	0.7	2.7	3.51	1.55	1.66	3.93	3.3	3.06	1.14	0.68	59.38
SG	23.25	0.64	4.11	0.42	4.45	2.85	1.32	1.29	5.55	2.78	6.19	0.53	0.53	76.75

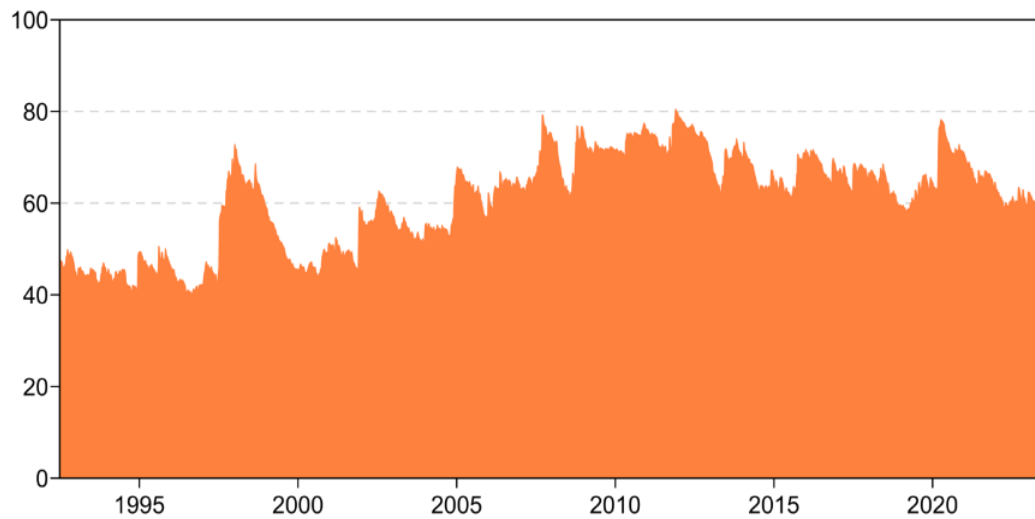		ZA	PK	PL	PH	PE	RU	TW	TR	TH	AE	QA	TO	Inc.Own	NET	NPT
SG	5.38	1.4	4.86	4.46	2.82	2.62	7.45	3.69	8.25	1.95	1.4	108.32	131.57	31.57	26
SA	0.7	0.92	0.66	0.66	1.05	0.62	0.6	1.03	0.61	4.68	2.68	27.1	86.51	-13.49	2
ZA	31.77	1.36	3.7	2.15	2.91	2.14	3.25	5.38	3.17	1.36	1.46	75.59	107.36	7.36	20
PK	0.63	63.7	0.37	0.78	1.29	1.22	0.75	0.71	0.72	1.04	1.47	21.22	84.92	-15.08	4
PL	4.32	0.98	25.35	2.54	2.85	3.38	3.8	3.84	3.58	1.53	1.3	91.74	117.08	17.08	22
PH	1.83	1.25	1.9	41	1.91	1.38	2.76	1.9	4.17	1.61	1.13	56.83	97.83	-2.17	12
PE	1.82	1.47	1.64	1.44	43.24	2.54	1.21	1.21	1.33	1.41	1.6	44.25	87.49	-12.51	5
RU	1.27	2.14	1.93	1.32	2.56	42.66	1.48	1.77	1.41	1.4	1.33	46.5	89.16	-10.84	8
TW	3.15	1.88	3.05	3.49	2.24	2.23	30.96	2.19	5.22	1.17	1.08	74.36	105.32	5.32	17
TR	5.19	1.66	3.45	2.3	1.94	2.44	2.12	36.46	2.39	1.11	1.3	71.59	108.05	8.05	17
TH	2.97	1.68	2.94	4.65	1.59	1.9	5.35	2.36	28.57	1.46	1.25	74.88	103.45	3.45	17
AE	0.62	1.04	0.5	0.61	1.38	0.82	0.54	0.5	0.72	54.88	3.29	29.67	84.54	-15.46	2
QA	0.67	1.33	0.34	0.63	1.22	0.65	0.51	0.52	0.53	3.48	60.95	25.16	86.11	-13.89	3
From	68.23	36.3	74.65	59	56.76	57.34	69.04	63.54	71.43	45.12	39.05	1636.23	cTCI/TCI	62.93/60.60	

Figure 4: TVP-VAR Total Connectedness Index (TCI)

Figure 4, represents the Total Connectedness Index (TCI) that is estimated from the TVP-VAR model for FX data of 27 emerging market economies. We can understand important results about the changes in the connectedness of the FX markets for included sample emerging market countries. Between 1992-1998, the TCI remained stable on average. After 1998 it started to increase because there were some changes in the monetary policy of the FED. The central bank of the US had to use strict conventional monetary policy to decrease the effects of the Russia Moratorium on the economy (FED,2021). During 2001, the FED applied an easing monetary policy to cover the liquidity needs of the banks and markets due to some terrorist attacks, therefore, these policy changes affected the other emerging markets, we can see the changes in the TCI on the same figure. From 1998 to 2008, the Fed used conventional monetary policy to affect economic conditions in the country and connectedness always changed over time until the 2008 Great Recession.

The Fed started using unconventional monetary policy after the 2008 crisis and it decreased the interest rate until zero lower band. During the crisis, additional monetary

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policy instruments such as Large-Scale Asset Purchases are used. This action can be the beginning of new fluctuations in the TCI with increasing rates. In continuation, we can see the effects of the Coronavirus (COVID-19) pandemic which impressed the whole world economy. After that, it started to decrease with both the US and the world economy starting to recover.

Total Directional Connectedness–FROM, in other words, directional from others represents the exchange rate risk connectedness from the system to each 27 emerging market economies. As we see in Figure 5, all markets fluctuate visibly over time, during different crisis periods. Singapore and Hungary's foreign exchange rate markets protect their leading position among the other markets. From 1992 to 2007 the risk was relatively high in these two markets. After the 2008 Great Recession, the risk increased in Singapore and Hungary, and also Greece, Poland, and the Czech Republic are added to the group of high-risk countries. We can see the changes in other markets in Figure 5.

Total Directional Connectedness – TO, in other words, directional to others demonstrates the exchange rate risk connectedness from others to each market for 27 emerging market economies. The graphs in Figure 6, reveal that Singapore and Hungary are important and dominant for risk transmission among all countries. Singapore and Hungary are leading countries aspect from bidirectional risk connectedness. In addition to these two countries; Greece, the Czech Republic, and Poland contribute to the transmission of risk.
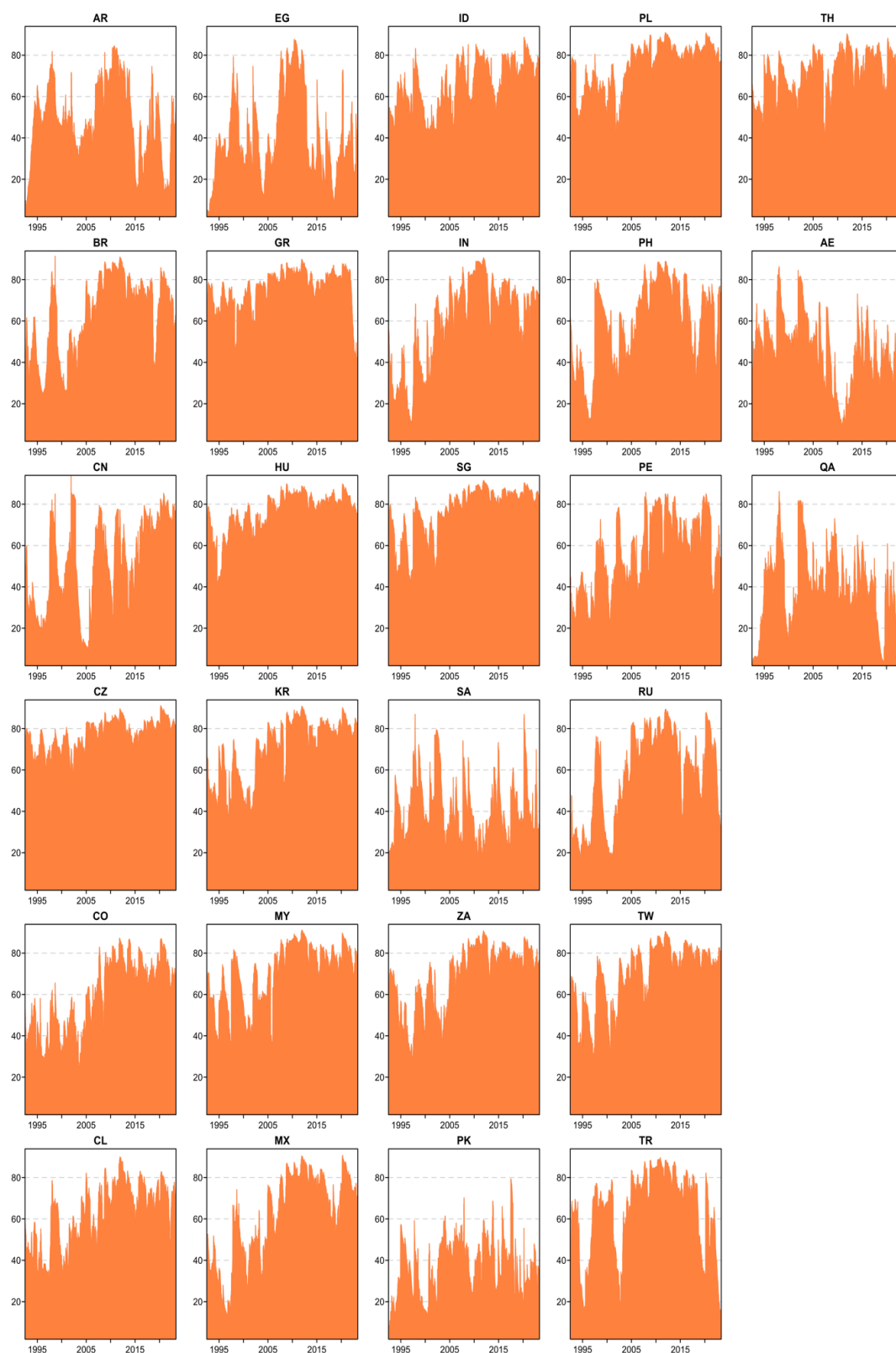
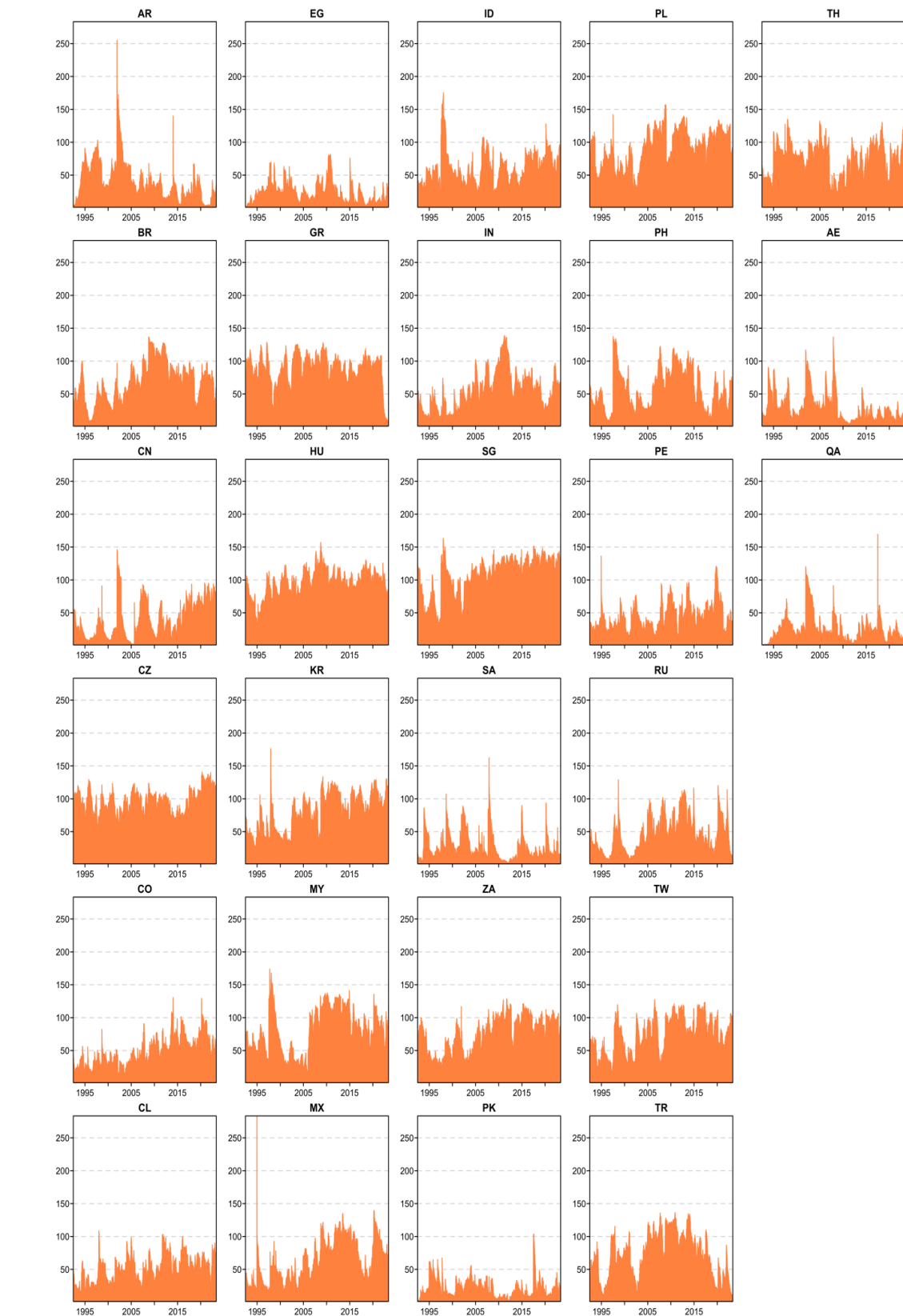Figure 5: Total Directional Connectedness – FROM

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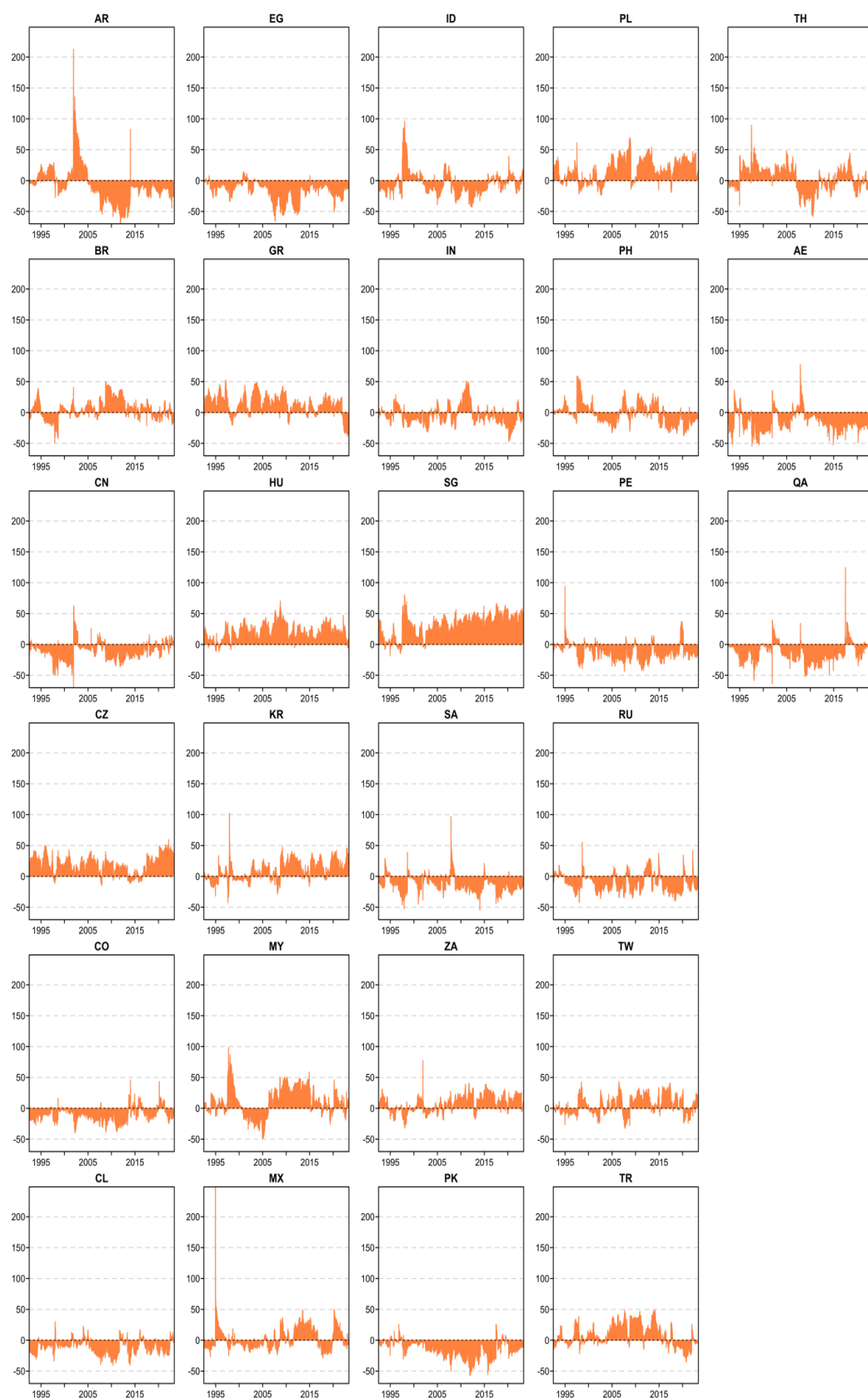
Figure 6: Total Directional Connectedness – TO

Figure 7: Total Directional Connectedness – NET

The last representation of the total directional connectedness is Figure 7. which shows the NET risk connectedness from and to each of the all emerging market economies over the period between 1992 and 2023. Egypt, Peru, China, Colombia, Pakistan, Saudi Arabia, and the Arab Emirates are net receivers of the exchange rate risk as we see in the figure that negative net connectedness. On the other hand, Singapore, Hungary, Greece, and the Czech Republic are the net emitters of the exchange rate risk. Singapore and Hungary are the most important net transmitter of risk, they transfer considerable risk to other markets, and they have positive net connectedness. In conclusion, all graphs indicate important fluctuations in the exchange rate risk transmission of foreign exchange markets for emerging market countries from 01/07/1992 to 10/05/2023.

5.3.2 Connectedness Network Analysis

We make the connectedness network analysis to get additional information by using the visual representation of the connectedness tables. This connectedness plot displays which markets are at the center of the exchange rate risk and which countries are in a safe zone means isolated from others in terms of risk exposure (Balcilar, M., Elsayed, A.H., & Hammoudeh, S. 2022). Thanks to the connectedness plot, we can understand the spread of the exchange rate risk connectedness among emerging market countries after the monetary policy shocks in the US.

Figure 8, represents the network diagram of the TVP-VAR connectedness for 27 emerging market countries. There are two types of colors which are blue and orange and different sizes of circles are big and small. While the big and blue circles present the risk-transmitter countries, the small and blue circles are also transmitters but these countries are too small to transmit the risk.

For instance, Singapore (SG), Czech Republic (CZ), Hungary (HU), Poland (PL), Greece(GR), and Malaysia (MY) are bigger transmitters of the exchange rate risk to other countries after the FED's monetary policy shocks happen. The small and blue countries such as Turkey (TR), Taiwan (TW), Thailand (TH), Brazil (BR), South Africa (ZA), and Mexico (MX) are also risk transmitters but the risk transmission is lower relative to the big and blues circles. The big-orange circles represent the risk-receiver countries. After the monetary policy shocks; countries such as Peru (PE), Russia (RU), Pakistan (PK), Egypt (EG), Qatar (QA), United Arab Emirates (AE), and Colombia (CO) are big receivers of the exchange rate risk. Small-orange countries like India (IN), Indonesia (ID), Philippines (PH) are getting a small share of the exchange rate risk exposure. In sum, we can understand which countries are receivers and transmitters from the direction of the arrows. In addition to all this, receivers and transmitters also share the risk among themselves (Figure 8).
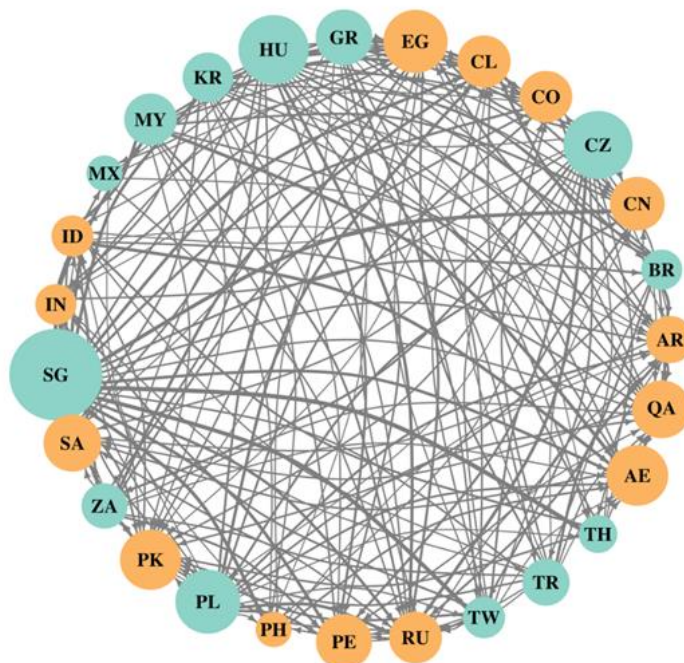

Figure 8: TVP-VAR Connectedness Plot or Directional Connectedness Network

5.3.3 The Effect of the US Monetary Policy Shocks on Exchange Rate Risk Connectedness in EMEs

In this section, we examine the role of the US monetary policy shocks in creating the risk connectedness of EMEs. The US monetary policy can have impacts on emerging market economies. Besides the US monetary policy shocks, there can be other factors that affect the emerging market exchange rate risk and connectedness among them due to trade or political ties. However, the study aims to investigate the effect of the monetary policy shocks in the US on the exchange rate contagion risk in emerging markets and connectedness among them. We want to answer this question: "Are the US monetary policy shocks the main driver of the exchange rate risk transmission among emerging market economies?". In this direction, we consider three monetary policy shock factors; The Federal Funds Rate Factor (FFRF), also known as conventional monetary policy, Forward Guidance Factor (FGF), and Large-Scale Asset Purchases Factor (LSAPF), often known as unconventional monetary policies. The connectedness tables for each emerging market economy are already given in the previous section.

To show this connectedness by using illustration we estimate the Time-Varying Regression of Total Connectedness and Monetary Policy Factors (Table 4.). After estimation, we create a time-varying regression analysis of total connectedness and monetary policy shocks (Figure 9.).

Table 4: Regression Estimates of the Time-Varying Total Connectedness on Monetary Policy Shock Factors

	Model 1	Model 2	Model 3
(Intercept)	59.938 *** (0.285)	59.940*** (0.285)	59.939 *** (0.285)
FFRF	0.218 (1.023)		
FGF		0.740 (0.674)	
LSAPF			0.184 (1.806)
N	1408	1408	1408
R^2	0.000	0.001	0.000

First of all, we make a regression analysis of the US monetary policy shock factors on the time-varying total connectedness estimated rolling window size of 4 years. The regression estimates are given in the table above.

Using the estimated regression results we can say that the impact of Federal Funds Rate, Forward Guidance, and Large-Scale Asset Purchases are not statistically significant. There is no statistical relationship between the monetary policy shocks and exchange rate risk connectedness of emerging market economies.

The illustrative results can be seen in Figure 9 which demonstrates the Time-Varying Regression Analysis of Total Connectedness and Monetary Policy Shocks which are FFRS, FGS, and LSAPS.

The Figure 9 represents the rolling regression slope estimates for each shock factor $\hat{\beta}_1$ the total time-varying connectedness is TC_t acquired from a rolling linear VAR model of three monetary policy shocks with a rolling window size of 4 years.

The effect of the US monetary policy shock factors on the exchange rate risk connectedness in emerging market economies can be time-varying. Therefore, clear results of the time-varying effect of the estimated regression coefficient of the monetary policy shocks by using a rolling regression can be seen in the figure below. The model $TC_t = \beta_0 + \beta_1 X_t + \varepsilon_t$ (X represents each policy factor: FFRF, FGF, LSAPF) is estimated by using the Ordinarily Least Square (OLS) for each window and slope of each estimate. From Figure 9, the gray-shaded areas represent the 95% confidence interval; and the blue horizontal line which is drawn to the zero band shows $\beta_1 = 0$, the null impact. The solid red horizontal line displays the estimates for OLS parameters and wide light red indicates their confidence interval in 95%. As a conclusion, the US monetary policy shocks do not have strong time-varying effects on the exchange rate risk connectedness of EMEs. Most of the estimates are negative or close to zero except for some positive periods.
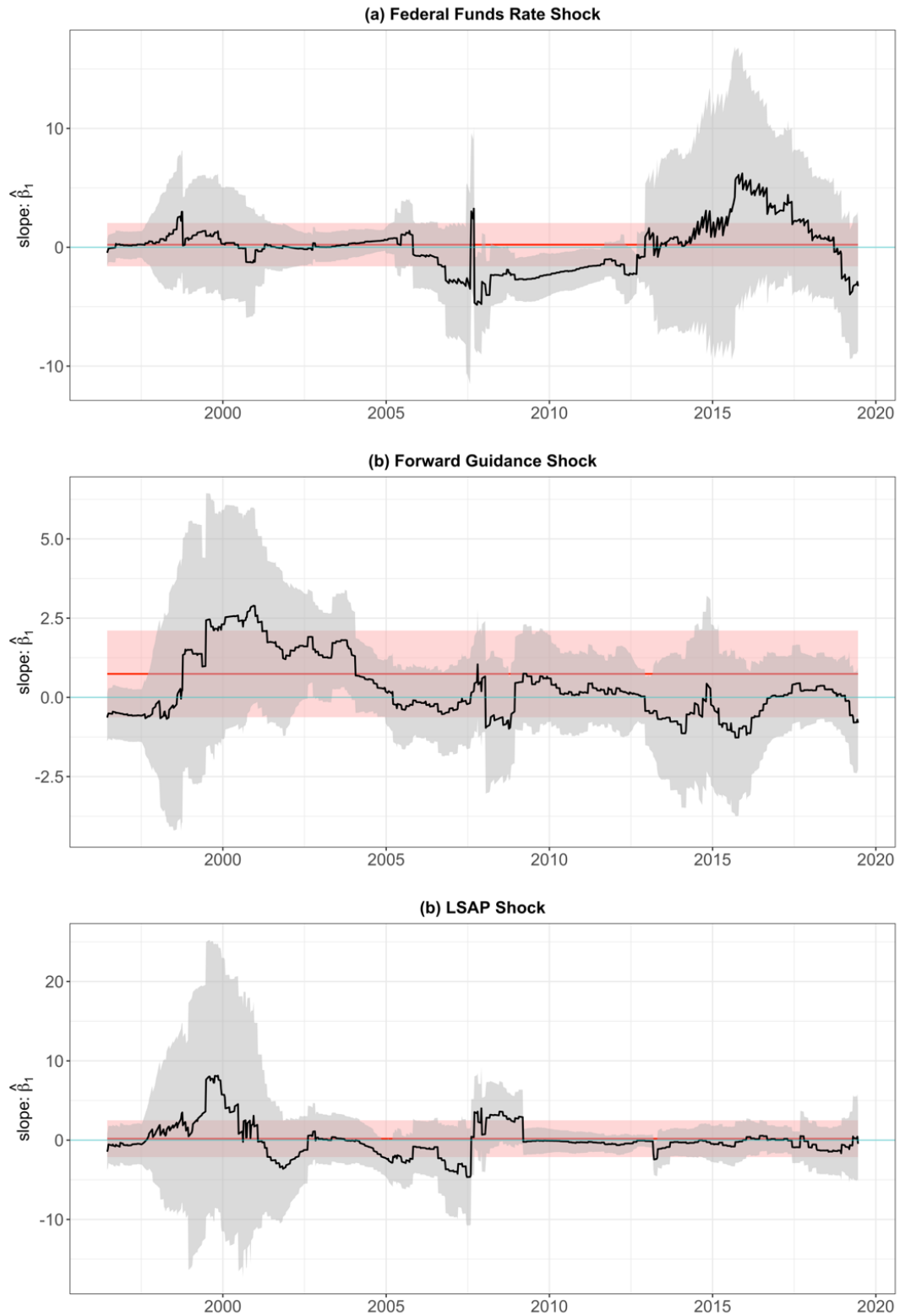
Figure 9: Time-Varying Regression Analysis of Total Connectedness and Monetary Policy Shocks

Chapter 6

CONCLUSION

With the share of emerging market economies in the world economy has gained importance, the number of studies examining these countries has gradually increased. EME countries are very important country groups in the current literature. According to a study by IMF, in recent years, emerging markets are an ever-more significant part of the world economy and they have a growing share of global GDP. On the other hand, these countries are riskier due to economic and political uncertainty, therefore, investors cannot see the future of their investments. They make a short-run investment plan instead of the long-run. These countries can be affected by positive and negative events in the advanced economies. They have vulnerable financial markets and weak economic indicators. Therefore, they feel the effects of the crisis more than other countries. Macroeconomic and financial stability depends on the stable economy in advanced countries. Instead of exchange rate movements, there can be other factors that affect these countries' economic conditions like political relations with others, external factors like a war between Ukraine-Russia, etc. However, we wonder impacts of the US monetary policy shocks on the exchange rate risk and connectedness of emerging markets.

The US is among the advanced economies and it has a leader position in the international economy. In addition to its economic size, it has a strong and valid exchange rate in the world.

The policy changes or any shocks in the US can affect the small open economies that are on the path of development and following developed countries.

Several studies in the literature are written to investigate the mechanism of the monetary policy shock transmission from the US to emerging market countries. After the Great Recession, the US changed its monetary policy from conventional to unconventional due to the inadequacy of the conventional policies anymore. The contribution of technological developments in every area is also an important factor in transmission of the risk from one country to another.

This study aims to investigate the impacts of changes in the US monetary policy on the exchange rate risk and connectedness of emerging markets economies. We use the Federal Funds Rate, Forward Guidance, and Large-Scale Asset Purchases as the policy changes. Large-Scale Asset Purchases are given in Appendix C with the important dates. Numerous studies analyze the effects of each monetary policy on different countries. In Chapter 2, we give detailed information about the US monetary policy and each monetary policy shock. And also, important channels, that are transmitting the impacts of shock, are given in the same section.

The definition of the exchange rate that has great importance for the international economy is given in Chapter 3. Due to the many types of exchange rate regimes, in this study, exchange rate regimes are explained according to the countries that we included. The choice of the exchange rate is an important issue for emerging market economies, as we explained in this chapter. In the following, the exchange rate risk for the sample countries is mentioned. In the literature review, we evaluate the previous studies that are related to our topic.

In the last part of the study, we explained the data and methodology which we used. We included 27 emerging market countries in this analysis and we collected the data from July 1992 to May 2023 by using the DataStream database. We use the TVP-VAR model to show the connectedness of emerging market economies. After the Great Recession, the connectedness approach among the countries gained importance, and many studies examining the spread of risk between countries have been carried out.

Moreover, connectedness studies have also become a popular method in recent years and have been used in this study. According to connectedness analysis of emerging markets, we found that there is a strong connectedness between some countries while others have connectedness but weaker than others. Thanks to the analysis, we can see which countries are net transmitters and which countries are net receivers of the risk. We gave Figure 8 to show clear results of the connectedness among the countries. This figure reveals the direction and level of the connectedness.

Lastly, we made a regression analysis and we reached the final result related to the impacts of the US monetary policy on the exchange rate risk. According to these results, there is no statistically significant result for the effects of monetary policy shocks. Model 2, only gives a little relation but it's very small to say there is a relation.

In conclusion, we find statistically insignificant results for the emerging market economies. Instead of the exchange rate risk, there can be other factors that affect the connectedness of these countries. In further studies, we can focus on what are the main drivers of connectedness among the emerging market countries or different country groups.

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APPENDICES

Appendix A: List of the Countries and Their Currencies

Country Name	Currency
Argentina	Peso
Brazil	Brazilian Real
China	Yuan
Czech Republic	Koruna
Colombia	Colombian Peso
Chile	Chilean Peso
Egypt	Egyptian Pound
Greece	Drachma
Hungary	Forint
South Korea	S. Korean Won
Malaysia	Ringgit
Mexico	Mexican Peso
Indonesia	Rupiah
India	Rupee
Singapore	Singapore Dollar
Saudi Arabia	Riyal
South Africa	Rand
Pakistan	Pakistan Rupee
Poland	Zloty
Philippines	Philippine Peso
Peru	Peruvian Sol
Russia	Ruble
Taiwan	Taiwan Dollar
Turkey	Turkish Lira
Thailand	Baht
United Arab Emirates	Dirham
Qatar	Qatari Riyal

Appendix B: First Round of Large-Scale Asset Purchases

Nov. 25, 2008	The FOMC announces that it will initiate a program to purchase up to $100 billion in agency debt securities and $500 billion of agency MBS to reduce the cost and increase the availability of credit for the purchase of houses.
Dec. 5, 2008	Large-scale purchases of agency debt begin.
Jan. 5, 2009	Large-scale purchases of agency MBS begin.
March 18, 2009	The FOMC announces an expansion of its asset purchase program, saying it will purchase a total of up to $1.25 trillion of agency MBS (an additional $750 billion) and up to $200 billion of agency debt (an additional $100 billion) by the end of the year to provide greater support to mortgage lending and housing markets. To help improve conditions in private credit markets, the FOMC also announces it will purchase up to $300 billion of longer-term Treasury securities over the next six months.
March 25, 2009	Large-scale purchases of Treasury securities begin.
Aug. 12, 2009	To promote a smooth transition in markets, the FOMC announces that it will gradually slow the pace of its Treasury purchase operations and that it anticipates completing these purchases by the end of October 2009. Following this announcement, the Desk decreases both the size of individual operations and the frequency of operations, moving from two operations per week to one operation per week and gradually reducing the size of its operations.
Sept. 23, 2009	The FOMC announces its intention to gradually slow the pace of purchases of agency debt and MBS in anticipation that purchases will be completed by the end of the first quarter of 2010.
Oct. 29, 2009	The Desk reaches $300 billion in outright Treasury securities purchases.
Nov. 4, 2009	The FOMC announces an adjustment in its total agency debt purchases from $200 billion to $175 billion, consistent with the recent path of purchases and reflecting the limited availability of agency debt.

March 2010	The Desk ends the first round of large-scale asset purchases. The initial reinvestment practice associated with the securities acquired under this purchase program is to exchange all maturing Treasury debt for new issues at Treasury auctions, consistent with historical practice, and to receive agency MBS and agency debt principal payments without reinvestment.
Aug. 10, 2010	The FOMC announces its intention to keep constant the Federal Reserve's holdings of securities at their current level by reinvesting principal payments from agency debt and agency MBS in longer-term Treasury securities. It will also continue to roll over the Federal Reserve's holdings of Treasury securities as they mature.

Source: Federal Reserve Bank of New York
https://www.newyorkfed.org/markets/programs-archive/large-scale-asset-purchases

Second Round of Large-Scale Asset Purchases (2010-2011) (cont.)

Nov. 3, 2010	The FOMC announces it will expand its holdings of securities to promote a stronger pace of economic recovery and to help ensure that inflation, over time, remains at levels consistent with its mandate. The FOMC announces its intent to purchase a further $600 billion of longer-term Treasury securities by the end of the second quarter of 2011, a pace of about $75 billion per month.
June 22, 2011	The FOMC announces it will complete purchases of $600 billion of longer-term Treasury securities by the end of the month and directs the Desk to continue reinvesting principal payments on all domestic securities in longer-term Treasury securities to maintain the size of the Federal Reserve's portfolio at approximately $2.6 trillion.

Source: Federal Reserve Bank of New York
https://www.newyorkfed.org/markets/programs-archive/large-scale-asset-purchases

Third Round of Large-Scale Asset Purchases (2012-2014) (cont.)

Sept. 13, 2012	The FOMC announces it will increase policy accommodation by purchasing additional agency mortgage-backed securities at a pace of $40 billion per month. The FOMC says that agency MBS purchases will continue, and it will undertake additional asset purchases until the outlook for the labor market improves substantially in the context of price stability.

Dec. 12, 2012	The FOMC announces it will continue purchasing agency MBS at a pace of $40 billion per month. The FOMC also announces it will purchase longer-term Treasury securities after its program to extend the maturity of its holdings of Treasury securities is completed at the end of 2012, initially at a pace of $45 billion per month. The FOMC says that purchases of Treasury securities and agency MBS will continue until the outlook for the labor market improves substantially in the context of price stability. The FOMC announces it will maintain its existing policy of reinvesting principal payments from its holdings of agency debt and agency MBS in agency MBS and, in January 2013, will resume rolling over maturing Treasury securities at auction.
Dec. 18, 2013	The FOMC announces plans to begin to slow the pace of asset purchases, adding to its holdings of agency mortgage-backed securities at a pace of $35 billion per month rather than $40 billion per month, and adding to its holdings of longer-term Treasury securities at a pace of $40 billion per month rather than $45 billion per month, starting in January 2014.
January-September 2014	The FOMC reduces the pace of Treasury and MBS purchases by $5 billion per month at each of its meetings.
Sept. 17, 2014	The FOMC publishes its Policy Normalization Principles and Plans, in which the Committee lays out its plans for reducing its holdings gradually and predictably primarily by ceasing to reinvest repayments of principal on securities held in the SOMA.
Oct. 29, 2014	The FOMC announces it will conclude its asset purchase program this month in light of the substantial improvement in the outlook for the labor market since the program's inception and sufficient underlying strength in the broader economy to support ongoing progress toward maximum employment in the context of price stability. The FOMC announces it is maintaining its existing policy of reinvesting principal payments from its holdings of agency debt and agency MBS in agency MBS and of rolling over maturing Treasury securities at auction.

Source: Federal Reserve Bank of New York
https://www.newyorkfed.org/markets/programs-archive/large-scale-asset-purchases

Appendix C: Monetary Policy Factors

DATE	FEDERAL FUNDS RATE FACTOR	FORWARD GUIDANCE FACTOR	LARGE-SCALE ASSET PURCHASES FACTOR
1991-07-05	-0.0528	0.6122	0.0829
1991-08-06	-1.7624	-0.0655	-0.3271
1991-08-21	1.3483	-0.6852	0.3851
1991-09-13	-0.2191	0.5076	-0.5474
1991-10-02	0.1163	0.1457	-0.2356
1991-10-30	-0.3028	0.2426	-0.2819
1991-11-06	-1.4813	-0.389	-0.3688
1991-12-06	0.127	0.2337	-0.0379
1991-12-18	0.319	0.3233	-0.2664
1991-12-20	-3.9013	-1.2243	-0.0713
1992-02-06	0.3064	-0.1059	0.0086
1992-04-01	-0.0885	0.2901	-0.1247
1992-04-09	-2.3357	-1.9294	0.8946
1992-05-20	0.318	0.2013	-0.3881
1992-07-02	-1.2613	1.7221	-0.6392
1992-08-19	0.3873	-0.1127	0.0189
1992-09-04	0.1877	-0.1289	0.2503
1992-10-07	0.3143	0.0939	0.0287
1992-11-18	0.3758	0.1324	-0.3447
1992-12-23	0.3326	-0.4192	0.2965
1993-02-04	-0.1136	0.2992	-0.1063
1993-03-24	0.2365	0.2362	-0.206
1993-05-19	-0.1463	-0.0739	-0.1429
1993-07-08	0.116	-0.0208	0.0624
1993-08-18	0.6136	-0.0165	-0.0252
1993-09-22	0.3298	-0.1272	0.1854
1993-11-17	-0.0399	0.1139	-0.1377
1993-12-22	0.2094	-0.3285	0.3
1994-02-04	0.9019	2.053	-0.0382
1994-03-22	-0.3825	-0.7124	-0.5607
1994-04-18	1.1904	0.802	0.3535
1994-05-17	0.7621	-2.1364	-0.0947
1994-07-06	0.0677	0.3893	-0.0958
1994-08-16	1.1206	-0.7659	-0.3041
1994-09-27	-0.6467	0.7788	0.011
1994-11-15	1.1161	-0.3582	-0.0327
1994-12-20	-1.9854	2.1238	-1.3529
1995-02-01	0.8013	0.6796	0.0802
1995-03-28	0.4821	0.2032	-0.0546
1995-05-23	0.1395	0.0184	0.0619
1995-07-06	-1.1568	-3.4116	0.4801

1995-08-22	0.4356	0.769	-0.1613
1995-09-26	0.5176	0.8589	-0.1424
1995-11-15	0.3602	0.377	0.0382
1995-12-19	-0.916	0.4445	-0.3207
1996-01-31	-0.1428	-0.2768	-0.0539
1996-03-26	0.0693	0.2903	-0.2824
1996-05-21	0.1984	0.3575	-0.0612
1996-07-03	-0.4959	0.3291	-0.4418
1996-08-20	-0.0449	0.4932	-0.1195
1996-09-24	-1.37	-0.1876	-0.2241
1996-11-13	0.0277	-0.1753	-0.2371
1996-12-17	0.2383	-0.0134	0.1185
1997-02-05	-0.1922	0.776	-0.1477
1997-03-25	0.6425	1.0719	0.2055
1997-05-20	-1.1094	0.2048	-0.1457
1997-07-02	0.0126	0.1768	-0.3032
1997-08-19	0.1893	0.3183	0.0049
1997-09-30	0.1425	0.0627	0.0582
1997-11-12	-0.1335	-0.2576	-0.1958
1997-12-16	0.094	-0.0742	-0.0088
1998-02-04	0.1006	0.468	-0.2097
1998-03-31	-0.0028	0.2544	-0.079
1998-05-19	-0.1035	-0.0001	-0.1194
1998-07-01	0.2903	0.0441	-0.0546
1998-08-18	0.2477	-0.0752	0.0598
1998-09-29	0.9672	-0.3375	0.1144
1998-10-15	-2.9603	-2.4332	-0.3738
1998-11-17	-0.0225	0.1287	-0.3387
1998-12-22	0.2151	-0.0014	-0.0055
1999-02-03	0.2094	0.2768	0.2118
1999-03-30	0.0659	-0.387	0.1443
1999-05-18	-0.0395	2.9835	-0.2453
1999-06-30	-0.3678	-1.7254	-0.1541
1999-08-24	0.5327	-0.49	-0.0544
1999-10-05	-0.4347	2.3462	-0.3615
1999-11-16	1.2575	0.5482	0.0827
1999-12-21	0.1886	0.8563	0.1042
2000-02-02	-0.3775	1.1098	0.2409
2000-03-21	0.101	0.3935	-0.2478
2000-05-16	0.7103	0.5494	-0.2483
2000-06-28	-0.1596	-0.1981	-0.0586
2000-08-22	-0.0425	0.6783	-0.3355
2000-10-03	0.0256	1.2013	-0.3226
2000-11-15	0.1507	0.1349	-0.4781
2000-12-19	0.8049	-0.2578	0.5124
2001-01-03	-4.0334	2.6939	0.0444

2001-01-31	0.8316	-0.7344	0.7924
2001-03-20	-0.2878	-1.0225	1.0006
2001-04-18	-5.7674	-0.1372	0.9075
2001-05-15	-1.0852	-1.4497	0.76
2001-06-27	1.2762	0.1831	-0.1713
2001-08-21	0.2449	-0.7854	0.5634
2001-10-02	-0.3513	-0.2621	0.433
2001-11-06	-1.6435	-0.8846	1.3002
2001-12-11	0.0916	-1.5986	0.2351
2002-01-30	0.3761	0.1204	-0.3955
2002-03-19	-0.1633	-1.162	-0.0507
2002-05-07	0.2803	-0.8223	0.4716
2002-06-26	0.1549	0.2172	0.0111
2002-08-13	0.8185	-2.9402	1.355
2002-09-24	0.3159	-0.4086	0.0436
2002-11-06	-2.1545	0.545	-1.2461
2002-12-10	0.0903	0.693	-0.2611
2003-01-29	0.3047	0.9744	0.0457
2003-03-18	0.211	-0.2129	-0.153
2003-05-06	0.5107	-2.3955	0.7233
2003-06-25	1.606	0.6574	-0.4157
2003-08-12	0.3002	-1.0697	0.1837
2003-09-16	0.2693	-0.1075	0.0068
2003-10-28	0.3265	-2.3187	0.1503
2003-12-09	-0.0291	1.5696	0.7962
2004-01-28	-0.223	4.4319	0.2286
2004-03-16	0.3326	-1.771	-0.1513
2004-05-04	-0.0093	0.5609	0.075
2004-06-30	-0.0468	-0.0481	0.3709
2004-08-10	0.3594	0.7461	-0.1665
2004-09-21	0.1499	-0.2519	-0.2136
2004-11-10	0.1976	-0.6317	-0.0502
2004-12-14	0.0635	-0.1725	-0.0747
2005-02-02	0.0371	-0.1468	-0.196
2005-03-22	0.1106	2.0778	0.6014
2005-05-03	0.05	0.6959	-0.2637
2005-06-30	0.0757	0.989	-0.6774
2005-08-09	0.213	-0.4931	-0.0746
2005-09-20	0.7183	-0.2786	-0.284
2005-11-01	0.0959	0.3896	-0.1212
2005-12-13	0.0902	-0.2964	-0.0319
2006-01-31	0.2948	0.6753	0.1081
2006-03-28	0.2454	1.1983	-0.0782
2006-05-10	0.2349	1.2488	-0.1938
2006-06-29	-0.04	-0.5808	0.2383
2006-08-08	-0.2635	-0.0312	0.057

2006-09-20	-0.0251	0.6957	-0.2287
2006-10-25	0.1407	-0.1804	-0.2265
2006-12-12	0.2328	-0.9068	-0.0488
2007-01-31	0.1043	-0.0917	-0.1182
2007-03-21	0.2377	-1.9887	0.5645
2007-05-09	0.0403	0.9269	-0.2506
2007-06-28	0.0939	0.4185	-0.1357
2007-08-07	0.2368	-0.6886	0.1569
2007-08-10	0.4016	0.3283	-0.2616
2007-08-17	0.7101	-0.6014	1.3685
2007-09-18	-2.2456	-0.5758	0.9525
2007-10-31	0.024	1.8714	-0.4441
2007-12-11	0.8929	-1.3742	-1.1662
2008-01-22	-2.7591	2.3911	0.5296
2008-01-30	-1.2648	-0.0678	0.7747
2008-03-11	1.3296	1.8285	0.985
2008-03-18	1.4094	-0.7948	0.0228
2008-04-30	-0.8034	-0.1611	0.4328
2008-06-25	0.1006	-0.3273	0.1409
2008-08-05	0.0689	-0.1506	0.5328
2008-09-16	1.812	-0.1191	0.4837
2008-10-08	-0.9952	1.292	0.1626
2008-10-29	-0.5087	-0.6957	-0.0753
2008-12-16	-1.9226	-3.2665	0.4599
2009-01-28	0.1792	-0.0808	0.3325
2009-03-18	-0.2756	-1.9285	-5.6307
2009-04-29	0.2122	0.6293	0.7556
2009-06-24	0.1365	1.373	0.7978
2009-08-12	0.1948	-0.1222	0.5309
2009-09-23	0.1786	-2.0931	0.2001
2009-11-04	0.1055	-0.2377	0.5513
2009-12-16	-0.1239	0.6135	0.177
2010-01-27	-0.0098	1.0977	-0.1752
2010-03-16	0.1552	-0.8026	0.212
2010-04-28	0.1096	-0.0509	0.3151
2010-06-23	0.1729	0.1096	-0.1267
2010-08-10	0.1297	-0.6059	-0.6651
2010-09-21	0.1999	-0.1874	-0.0621
2010-11-03	0.4048	-0.2498	0.8113
2010-12-14	0.1927	0.005	0.3125
2011-01-26	0.1561	-0.1701	0.2999
2011-03-15	0.0856	0.5282	0.1064
2011-04-27	0.0781	-0.3502	-0.1258
2011-06-22	0.1288	0.383	0.2197
2011-08-09	0.4652	-1.522	-0.2486
2011-09-21	0.1982	0.9489	-1.2882

2011-11-02	0.112	0.3465	-0.1243
2011-12-13	0.1499	0.1627	-0.3305
2012-01-25	0.1058	-0.5627	-0.6539
2012-03-13	0.1428	0.431	0.3942
2012-04-25	0.0685	0.1478	0.1434
2012-06-20	0.1434	0.3734	-0.7396
2012-08-01	0.1191	0.6602	0.2016
2012-09-13	0.3472	0.5124	1.0139
2012-10-24	0.0742	0.0876	-0.1872
2012-12-12	0.2276	-0.026	0.4315
2013-01-30	0.1639	-0.2233	0.0744
2013-03-20	0.2112	0.0421	0.7655
2013-05-01	0.1766	-0.1298	-0.6982
2013-06-19	0.1555	1.2789	1.9618
2013-07-31	0.0941	0.0813	-0.2298
2013-09-18	0.0775	-1.3437	-2.5478
2013-10-30	0.1	0.0841	0.3262
2013-12-18	0.2132	0.0179	0.6277
2014-01-29	0.2178	-0.0378	-0.2412
2014-03-19	0.0635	1.0383	0.5745
2014-04-30	0.149	0.1236	0.044
2014-06-18	0.0883	0.4083	-0.1639
2014-07-30	0.147	-0.0931	-0.2256
2014-09-17	0.0745	0.7499	0.1599
2014-10-29	0.0876	0.8784	-0.0121
2014-12-17	0.2895	-1.539	0.5004
2015-01-28	0.1562	-0.1374	-0.136
2015-03-18	0.1905	-2.4187	-0.7684
2015-04-29	0.2009	0.3058	0.8709
2015-06-17	0.0942	-0.6491	0.1424
2015-07-29	0.0585	0.4825	0.1979
2015-09-17	-0.5335	-1.5287	-0.6352
2015-10-28	0.1122	1.8037	-0.0543
2015-12-16	0.3133	-0.0165	-0.535
2016-01-27	0.0061	-0.4571	-0.0646
2016-03-16	-0.1059	-1.8125	0.0361
2016-04-27	0.1044	0.3297	-0.2548
2016-06-15	0.0403	-0.7779	0.1874
2016-07-27	0.0919	0.1571	-0.3179
2016-09-21	-0.3929	-0.1762	-0.4677
2016-11-02	0.1187	0.1751	-0.0474
2016-12-14	0.0293	1.3897	0.235
2017-02-01	0.1318	-0.3792	0.1273
2017-03-15	0.2457	-1.3124	0.0288
2017-05-03	0.1931	0.4046	-0.0006
2017-06-14	0.3192	0.3507	0.0122

2017-07-26	0.0966	-0.2104	-0.2056
2017-09-20	0.0498	1.1731	-0.1235
2017-11-01	0.1391	0.1403	0.021
2017-12-13	0.1951	-0.2118	-0.1677
2018-01-31	0.1757	0.249	0.1555
2018-03-21	0.1233	0.1086	0.3651
2018-05-02	0.1627	-0.1906	-0.0983
2018-06-13	0.0159	0.8383	0.1004
2018-08-01	0.1917	-0.0519	-0.0558
2018-09-26	0.3094	-0.1885	0.0389
2018-11-08	0.1275	0.2713	-0.055
2018-12-19	0.4958	-0.0434	-0.4828
2019-01-30	0.1321	-0.6669	0.0756
2019-03-20	0.3628	-1.2167	-0.1823
2019-05-01	-0.0233	-0.6911	0.059
2019-06-19	0.4839	-2.0175	0.7116