ESSAYS ON SPILLOVER EFFECTS OF ECONOMIC AND GEOPOLITICAL UNCERTAINTY

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ABSTRACT

We are living in an age of uncertainty. While uncertainty can originate from multiple sources, the most prominent ones include economic policies and geopolitical conditions. Over the past two decades, geopolitical and economic policy uncertainties have risen dramatically around the globe, raising concerns among policymakers and financial market participants about the cross-country and cross-market transmission effects of these uncertainties. Consequently, a growing body of literature has emerged around the measurement of uncertainty, the cross-country transmission of uncertainty, and the spillover effects of a given uncertainty for financial markets. By offering several advantages over other measures of uncertainty, news-based uncertainty indicators have become increasingly popular since the seminal work by Baker, Bloom, and Davis (2016). As the transmission of geopolitical uncertainty across countries and that of economic policy uncertainty to financial markets carry important implications for risk-management and policy-making decisions, it is crucial to understand and explain the behavior of these transmission mechanisms. By relying on news-based indicators of geopolitical and economic policy uncertainty, this thesis contributes to the literature by exploring the potential determinants of uncertainty transmission to stock markets as well as across countries.

The first essay estimates and explains the cross-country transmission of geopolitical uncertainty (GPU). Using the news-based GPU indices for a sample of emerging economies along with the United States, the spillover models are employed to measure the pairwise and system-wide transmission of GPU. A substantial amount of GPU transmission is found across the sample countries, with some countries and geographical clusters are being more prominent than others. A cross-sectional analysis, motivated by a gravity model framework, is further

utilized to explain the pairwise transmission of GPU, which reveals that bilateral linkages and country-specific factors play an essential role in driving the transmission of GPU. The overall findings continue to hold even after considering the short- and long-term time horizons. The findings of this essay may help predict the trajectory of GPU from one country to another, which is an essential input for the assessment of cross-border investment appraisals as well as international stability initiatives.

A bulk of the literature has examined the impact of US uncertainty on international stock markets without paying much attention to the correlation between the US and the other stock markets. Motivated by this void in the extant literature, the second essay examines the role of US uncertainty in driving the US stock market's spillovers to global stock markets, after controlling for the stock market correlation. To this end, I consider a wide range of stock markets around the world, as well as three news-based uncertainties from the US, namely economic policy uncertainty, equity market uncertainty, and equity market volatility. I find that the US uncertainties significantly cause the spillovers from the US to global stock markets. This causality from US uncertainties depends upon certain country-characteristics. Specifically, the US uncertainties explain better the spillovers between US and target countries, when those countries have a higher degree of financial openness, trade linkage with the US, and vulnerable fiscal position. Improved levels of stock market development in the target countries, however, mitigate their stock markets' vulnerability to the US uncertainty shocks. The essay offers potential insights and implications for investors and policymakers.

Inspired by the concerns that small open economies may well be more vulnerable to foreign uncertainty than to local uncertainty, the third essay focuses on New Zealand, which is a small open economy. This essay introduces a weekly index of economic policy uncertainty (EPU) for New Zealand and, and examines the return and volatility spillovers from NZ EPU

and US EPU on the aggregate (NZSE) and sectoral indices of New Zealand stock market. Overall, the findings suggest that NZ equity sectors and NZSE receive stronger and more pronounced spillover effects from US EPU compared to the local counterpart. While the return spillovers from both EPUs are somewhat similar yet limited to just a few sectors, the volatility spillovers from US EPU on NZ sectors outstrip those from the NZ EPU. For volatility spillovers, the domestically oriented sectors are relatively more vulnerable to NZ EPU, while those having export/import concentration with the US are mainly susceptible to US EPU. The findings of this essay may be useful to investors seeking sectoral diversification opportunities across New Zealand and the US.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
BEKK	Baba, Engle, Kraft, and Kroner
BK	Barunik and Krehlik (2018)
BRIC	Brazil, Russia, India, China
BRICS	Brazil, Russia, India, China, South Africa
CEPII	French Research Center in International Economics
DCC	Dynamic Conditional Correlation
DY	Diebold and Yilmaz (2012)
EME	Emerging Market Economies
EMU	Equity Market Uncertainty
EMV	Equity Market Volatility
EPU	Economic Policy Uncertainty
EU	European Union

FDI	Foreign Direct Investment
GARCH	Generalised Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GPU	Geopolitical Uncertainty
GVD	Generalised Variance Decomposition
HAC	Heteroskedasticity and Autocorrelation Consistent
IMF	International Monetary Fund
MIDAS	Mixed Data Sampling Regression
MSCI	Morgan Stanley Capital International
NZ	New Zealand
NZSE	Aggregate Index of New Zealand Stock Exchange
OECD	Organization for Economic Development and Cooperation
QMLE	Quasi Maximum Likelihood Estimation

RBNZ	Reserve Bank of New Zealand
SV	Spillover Vulnerability
TMT	Technology, Media, and Telecom
UK	United Kingdom
US	United States of America
VAR	Vector Auto-Regression
WDI	World Development Indicators
WSJ	Wall Street Journal

1 CHAPTER 1 INTRODUCTION

This chapter provides an overview of the three essays included in the thesis. In particular, it explains the motivation and the significant contribution each essay makes to the current body of knowledge on the spillover effects of geopolitical and economic policy uncertainties. The chapter concludes by outlining a roadmap for the balance of the thesis.

1.1 Introduction

Over the last two decades, uncertainties resulting from economic and geopolitical conditions have increased significantly around the globe. Consider the case of geopolitical uncertainty (hereinafter GPU)[1] first. Several geopolitical events such as the Gulf War, the 2003 Iraq invasion and 9/11 in 2001, the more recently occurring Ukraine/Russia crisis, the terrorist attacks in Paris, the ongoing escalation of the Syrian conflict, the US-North Korea tensions over nuclear proliferation, the Qatar–Saudi Arabia proxy conflict, the US's recognition of Jerusalem as Israel's capital, the US's cancellation of Iran's nuclear deal, and the most recent killing of an Iranian commander by the US and the prompt Iranian revenge[2] indicate towards a heightened GPU in the recent years. Realizing the gravity of this situation, several international agencies, including the International Monetary Fund (IMF) and the World Bank, have

[1] In order to achieve consistency in this thesis, I prefer to use the term 'geopolitical uncertainty' instead of 'geopolitical risk', as doing so resonates well with the other uncertainty concepts used in the thesis and makes all the chapter more coherent. I understand that though the concepts of 'geopolitical uncertainty' and 'geopolitical risk' are closely related and hence can be used interchangeably, they could still be distinct in some respects.
[2] While this is the most recent example of a geopolitical event that almost led to a war between Iran and the US in 2019, we list it only to emphasise the heightened level of GPU. We understand that, unlike the other geopolitical events listed here, although this event is fresh in the memories of people living through these times, it would be a very vague concept for many readers a few years from now.

frequently published reports[3] that highlight growing concerns among policymakers, investors, and corporate managers about the contagious nature of GPU.

As with GPU, concerns about rising economic policy uncertainty (hereinafter EPU) have intensified in recent years. Several economic and political events, such as partisan policy disputes in the US, serial crises in Europe, the 2007-2008 global financial crisis (GFC), and Brexit, have raised serious concerns among investors, financial analysts, and regulators across the world (as noted by Baker, Bloom, & Davis, 2016). These economic agents are particularly worried about how changes in US EPU are transmitted to domestic stock markets. A perfect example was the US President Donald Trump's decision in June 2018 to increase tariffs on imports from Canada, the European Union, and China in particular. The uncertainty generated by this policy decision triggered an immediate response from local investors and international market participants. Consequently, a tremendous amount of volatility was seen around that time in many financial markets across the world, including China, Japan, Europe, and the US. This example underscores the importance of US EPU and the spillover effects that it may exert on international stock markets. That is why the IMF has repeatedly warned about the threat of another financial crisis that may arise from the expansionary policies followed by major economies[4] over the recent decade.

Motivated by the examples listed above, which show that understanding the transmission effects of EPU and GPU is of paramount importance to the economic agents, a wide variety of literature has emerged over the past two decades. For both types of uncertainties, the literature ranges from developing an appropriate measure for a given

[3] See Suárez-de Vivero and Mateos (2017) for a good collection of such reports.
[4]See, for instance, World Economic Outlook (2011) and Foreign Financial Stability Report (2012) published by the IMF.

uncertainty to the macro-financial effects of the uncertainty. More specifically, the strands of literature that have drawn considerable attention from the academic community include the measurement of uncertainty using news articles, the cross-country transmission of uncertainty, and the spillover effects of a given uncertainty for financial markets – in particular, stock market.

As far as the measurement of uncertainty is concerned, the literature suggests three approaches[5] to measure uncertainty (see Bloom, 2014; Bontempi et al., 2016; Moore, 2016). However, the text-based approach is the most contemporary one which has gained enormous currency recently (see, Bontempi et al., 2016; Dzielinski, 2012; Gentzkow & Shapiro, 2010; Hoberg & Phillips, 2010; Boudoukh et al., 2013; Alexopoulos & Cohen, 2015; and Baker, Bloom, & Davis, 2016). Text-based measures offer several appealing features, including consistency, broad coverage, and a clear indication of the uncertainty sources (Alexopoulos & Cohen, 2009), and are therefore considered reliable barometers of uncertainty. Among text-based measures, uncertainty indicators computed from news articles have topped the list. In particular, the EPU index created by Baker et al. (2016) and GPU index developed by Caldara and Iacoviello (2018) are the most extensively used news-based indicators of uncertainty. Because of the attractiveness of the text-based measures, this thesis mainly relies on these two news-based indicators for the empirical investigation[6].

As for the cross-country transmission of uncertainty, much of the literature supports the existence of EPU spillovers across a wide range of countries (Klößner & Sekkel, 2014; Yin & Han, 2014; Kang & Yoon, 2019). In today's economically integrated world, the possibility of

[5] I will explain the measurement approaches in Section 4.2.1 of Chapter 4.
[6] Although the second essay (Chapter 3) makes use of two additional indicators of uncertainty, which are also developed by the news-based method, the focus of this thesis remains on GPU and EPU.

cross-country transmission of EPU is much more plausible. Studies have found that the existence of trade and financial linkages among world economies determines the transmission of EPU concerns from one country to another (Balli, Uddin, Mudassar, & Yoon, 2017). Similarly, the transmission of GPU concerns may well be explained by the bilateral linkages, as the construction of the GPU index, just like the EPU index, is based on news stories that are transmitted equally across countries. However, only a little attention has been paid to the cross-country transmission of GPU, even though the further understanding of GPU transmission is no less critical for the economic agents' decision-making process – as I highlight above. Provided that news stories featuring geopolitical conflicts contain information about GPU associated with those conflicts (Caldara & Iacoviello, 2018), estimating GPU transmission using indicators that are driven from news articles seems natural.

Given the importance of GPU for economic agents' decision making along with the paucity of literature around GPU transmission, the first essay relies on the conflict contagion literature. It uses the news-based indicators of GPU, developed by Caldara and Iacoviello (2018), for emerging economies and the United States. The conflict contagion literature often documents that the flow of media information is responsible for carrying geopolitical conflicts across countries (Beiser, 2013; Hill & Rothchild, 1986; Weidmann, 2015). Accordingly, it examines the cross-country transmission of GPU across a set of 19 countries (18 emerging economies and the US) and explores the underlying determinants of this transmission. In this way, the first essay relates not only to the literature on conflict contagion but also to the literature on uncertainty transmission.

As far as the nexus between uncertainty and the stock market is concerned, there is an abundance of literature addressing this issue. Most studies assess the effect of EPU on the performance of the stock market. The seminal work of Pástor and Veronesi (2012) lays out theoretical foundations for the potential effects of EPU on the returns and volatility of the stock market. On a domestic front, EPU tends to decrease return and increase the volatility of the stock market fear via investor sentiment when economic policies are hard to anticipate among market participants. Higher uncertainty around economic policies also raises stock market fear through the stochastic discount factor, which shoots up risk-premia and, thereby, volatility in stock markets (Pástor & Veronesi, 2012). Most of this literature, however, examines the relationship between EPU and stock market performance within the context of US (Pástor & Veronesi, 2012 & 2013; Antonakakis, Chatziantoniou, & Filis, 2013; Brogaard & Detzel, 2015; Bijsterbosch & Guerin, 2013; Liu & Zhang, 2015). Apart from these domestic effects, US EPU carries a significant potential to cause return and volatility spillovers on several international stock markets (Dakhlaoui & Aloui, 2016; Ko & Lee, 2015).

In this strand of literature, two issues, however, remain reasonably unexplored. The first issue that seems to prevail throughout the uncertainty-stock market literature is that, most often, the attempts have been made to establish a direct connection between US EPU and the performance of global stock markets – where stock market performance is typically measured in terms of return or volatility of the stock markets (e.g., Chuliá et al., 2017, Ko & Lee, 2015, Lam & Zhang, 2014; Phan, Sharma, & Tran, 2018; and Su, Fang, & Yin, 2019). The underlying assumption is that a country's stock market performance is directly affected by external uncertainties, especially if the uncertainty shocks are originated from a major economy like the US. This assumption, however, may not withstand once we account for the fact that most international stock markets tend to co-move with the US market (Bekaert, Harvey, Lundblad, & Siegel, 2011). It follows then that international stock markets may well be more responsive to the changes from the US stock market than those from the US uncertainties. Accordingly, an alternative argument may be constructed that US uncertainties first lead to fluctuations in the US stock market, which then makes the other stock markets move. Hence, their performance appears to be affected by US uncertainties. Consequently, the US uncertainties may lead the co-movement (or spillovers) between the US and international stock markets, and, therefore, may serve as a driver for stock market spillovers. Accordingly, the second examines the role of US uncertainty in driving the US stock markets spillover to global stock markets, after controlling for the stock market correlation, which has been largely ignored in the previous literature.

The second issue partly relates to the overwhelming emphasis that has been put on the spillover effects of US EPU for the aggregate stock markets of various regions. The issue also concerns the simultaneous examination of the EPU spillovers emanating from the local and the international landscape on the various sectors of a small-open economy's stock market, which has received little attention in the literature. It has been argued that EPU spillovers for international stock markets may even be stronger if the EPU shocks are emanating from a large economy (Sum, 2013), such as the US, and more so if the target country happens to be a small open economy (Stockammar & Österholm, 2016). In order to fill this void in the literature, the third essay considers the EPU spillovers from local and foreign landscapes on the aggregate and sectoral indices of New Zealand – a textbook small open economy.

1.2 Essay one

The first essay estimates and explains the cross-country transmission of geopolitical risk (GPU). Using news-based GPU indices for a sample of emerging economies along with the United States, the spillover models are employed to measure the pairwise and system-wide transmission of GPU. A substantial amount of GPU transmission is found across the sample countries, with some countries and geographical clusters being more prominent than others. A cross-sectional analysis, motivated by a gravity model framework, is further utilized to explain the pairwise GPU transmission, which reveals that certain bilateral linkages and country-specific factors play an essential role in driving the transmission of GPUs. The overall findings continue to hold even after considering the short- and long-term time horizons. This essay may help predict the trajectory of GPU, which is an essential input for the assessment of cross-border investment appraisals as well as international stability initiatives.

By contributing to the literature, the first essay proposes another perspective by studying the transmission of GPU which takes place in the form of information flows associated with geopolitical conflicts, and this is in contrast to the previous studies that regard information flows as one of the factors responsible for physically spreading the conflicts across borders (Beiser, 2013; Hill & Rothchild, 1986; Weidmann, 2015). Furthermore, contrary to the previous studies that aimed to predict wars by relying on a measure of geopolitical tensions (Chadefaux, 2014), this essay points towards bilateral linkages and country-specific factors that explain GPU transmission.

1.3 Essay two

Studies in the extant literature have examined the impact of US uncertainty on international stock markets without paying much attention to the correlation between the US and the stock markets. I examine the role of US uncertainty in driving the US stock markets spillover to global stock markets, after controlling for the stock market correlation. To this end, I consider a wide range of stock markets around the world, as well as three news-based uncertainties from the US, namely EPU, equity market uncertainty (EMU), and equity market volatility (EMV). I find that the US uncertainties significantly cause the spillovers from the US to global stock markets. This causality from US uncertainties depends upon certain country-characteristics. Specifically, the US uncertainties better explain the spillovers between US and target countries, when those countries have a higher degree of financial openness, trade linkage with the US, and vulnerable fiscal position. Improved levels of stock market development in the target countries, however, mitigate their stock markets' vulnerability to the US uncertainty shocks. The essay offers potential insights and implications for investors and policymakers.

This essay contributes to the broader debate linking foreign and local uncertainties to domestic stock markets (see, e.g., Boutchkova et al., 2012; Pástor & Veronesi, 2012 & 2013; and Smales, 2016). The main contribution of this essay is that it suggests that US uncertainties affect global stock markets, even after controlling for the time-varying correlation between the US and a given stock market. Only a little evidence was present on the topic previously (Li & Peng, 2017). Moreover, this essay provides global evidence on how US uncertainties drive spillovers between the US and other stock markets, going beyond individual markets and specific regions. Finally, and most importantly, this essay moves the US uncertainty-global stock market nexus literature (for instance, Phan et al., 2018) one-step further by indicating the potential factors that explain this nexus.

1.4 Essay three

The third essay introduces a weekly index of economic policy uncertainty (EPU) for New Zealand, and examines the return and volatility spillovers from New Zealand (local) and US (foreign) EPU on aggregate (NZSE) and sectoral indices of New Zealand stock market. The multivariate VAR (1)-BEKK-GARCH model is employed for this purpose. Overall, the findings suggest that NZ equity sectors and NZSE receive much stronger and more pronounced spillover effects from US EPU compared to the local counterpart (NZ EPU). While the return spillovers from both EPUs are somewhat similar yet limited to just a few sectors, the volatility spillovers from US EPU on NZ sectors outstrip those from the NZ EPU. For volatility spillovers, the domestically oriented sectors are relatively more vulnerable to NZ EPU, while those having export/import concentration with the US are mainly susceptible to US EPU. These findings may be useful to investors seeking sectoral diversification opportunities across New Zealand and the US.

This essay contributes explicitly to the EPU measurement literature by introducing a weekly EPU index for New Zealand. Unlike the previous research (e.g., Greig, Rice, Vehbi, & Wong, 2018; Armelius, Hull, & Köhler, 2017; Stockammar & Österholm, 2016; and Kamber, Karagedikli, Ryan, & Vehbi, 2016) that pays little attention to the relationship between local EPU and equity sectors of small open economies, this essay considers New Zealand as a representative small open economy, and simultaneously examine the local and foreign EPU spillovers for the equity sectors of New Zealand. In this respect, the contribution provided by the third essay joins with the ongoing debate on the EPU-equity sector nexus and is linked closely to the current research in the area (Yu et al., 2018; Yu et al., 2017).

1.5 The research output of the thesis

1.5.1 Essay one

The first essay included in this thesis is under review at The Annals of Regional Science. To date, this essay has been presented at the following forums:

a) Mudassar Hasan, Faruk Balli, Hatice-Ozer Balli, and Russell Gregory-Allen (2018), “Bilateral and country-specific drivers of geopolitical risk transmission,” 8th Annual New Zealand Finance Meeting, Queenstown, New

Zealand, 17-19 December 2018. The Auckland Centre for Financial Research hosted the meeting at the Faculty of Business, Economics and Law, Auckland University of Technology.

b) Mudassar Hasan, Faruk Balli, Hatice-Ozer Balli, and Russell Gregory-Allen (2019), "Bilateral and country-specific drivers of geopolitical risk transmission," 23rd Annual New Zealand Finance Colloquium, Lincoln, New Zealand, 13-15 February 2019. The colloquium was hosted by the Faculty of Agribusiness and Commerce at Lincoln University in Lincoln, Canterbury.

1.5.2 Essay two

The second essay included in is under review at the International Review of Economics and Finance.

1.5.3 Essay three

The third essay included in this thesis is published in the Journal of Economics and Finance.

In connection to this essay, I created an EPU index for New Zealand with two frequencies, i.e., weekly and monthly. The weekly EPU index has been used in this essay, while the monthly EPU index has been used in the following two publications:

a) Balli, F., Uddin, G. S., Mudassar, H., & Yoon, S. M. (2017). Cross-country determinants of economic policy uncertainty spillovers. Economics Letters, 156, 179-183.

b) Tsui, W. H. K., Balli, F., Tan, D. T. W., Lau, O., & Hasan, M. (2018). New Zealand business tourism: exploring the impact of economic policy uncertainties. Tourism Economics, 24(4), 386-417.

1.6 Structure of the thesis

The balance of the thesis is structured as follows. The first essay, which examines the transmission of GPU and its potential determinants, is presented in Chapter 2. The second essay which examines the role of US uncertainty is causing the US stock markets spillover to global stock markets, after controlling for the stock market correlation, and which further explores the underlying determinants of this causality is presented in Chapter 3. Chapter 4 presents the third essay which introduces a weekly EPU index for New Zealand and examines the return and volatility spillovers from New Zealand (local) and US (foreign) EPU on aggregate and sectoral indices of New Zealand stock market. Chapter 5 concludes the thesis by including key findings and implications of the three essays and the potential areas of research.

2 CHAPTER 2 ESSAY ONE

Cross-country transmission of geopolitical uncertainty and its drivers

The first essay estimates and explains the cross-country transmission of GPU. Using GPU indices of Caldara and Iacoviello (2018), the spillover models are employed to estimate the pairwise and system-wide transmission of GPU. A substantial amount of GPU transmission is found across sample countries, with some countries and geographical clusters are being more prominent than others. Motivated by a gravity model framework, a cross-sectional regression is utilized to explain the pairwise transmission of GPU, which reveals that bilateral linkages and country-specific factors play an essential role in driving the transmission of GPU from one country to another. The overall findings continue to hold even after considering the short- and long-term time horizons. The findings of this essay may help predict the trajectory of GPU, which is an essential input for the assessment of cross-border investment appraisals as well as international stability initiatives.

2.1 Introduction

This research investigates whether and why the transmission[7] of GPU occurs across countries. Caldara and Iacoviello (2018) show that news stories featuring geopolitical conflicts contain information about the GPU associated with the conflicts. Primary examples of such geopolitical conflicts include wars, terrorist acts, ethnic and political violence, and geopolitical tensions. On the other hand, conflict contagion literature considers the role of information flows in spreading individual conflicts across borders. It is argued that media information associated with a domestic conflict flows across borders, increasing the likelihood of similar conflict there (Beiser, 2011). More specific instances in which the flow of media information carried geopolitical conflicts across countries include political conflict, armed civil conflict, and ethnic conflicts (Beiser, 2013; Hill & Rothchild, 1986; Weidmann, 2015). Since the media information about each of those conflicts essentially reflects GPU about the conflict, one may argue that the flow of media information does not merely cause the spread of physical conflicts, but rather carries GPU of that conflict from country to another. A theoretical expectation, thus, exists about the transmission of GPU occurring in the form of information flow. This essay thus asks whether the transmission of GPU occurs in the form of information flows.

The essay further asks why the transmission of GPU may occur. In this case, the essay relies on another stream of conflict contagion literature where a disease-conflict analogy is often employed to explain the cross-country transmission of the geopolitical conflicts. Instances, where this analogy has been explicitly used, include the spread of political violence (Braithwaite, 2010; Buhaug & Gleditsch, 2008) and terrorism (Blomberg & Rosendorff, 2006). This analogy proposes that the magnitude of conflict spread varies with the extent of social

[7]Instead of distinguishing between contagion, spillover, diffusion, and spread, we view the phenomenon as transmission mechanism/process because essentially that is what they reflect.

interaction between two countries (Buhaug & Gleditsch, 2008) and that a gravity model framework successfully captures this kind of interaction. As GPU transmission is expected to happen via information flow, one needs to appreciate whether the gravity model framework works for information flows. Literature suggests this framework has been successfully employed to explain other forms of information transmission such as economic reforms (Fidrmuc & Karaja, 2013), stock market volatilities (Balli, Balli, Louis, & Vo, 2015), and economic policy uncertainties (Balli, Uddin, Mudassar, & Yoon, 2017). Therefore, this essay uses this framework to explain the cross-country transmission of GPU. In this way, this essay aims to deepen the understanding of investors, corporate managers, and policymakers about the contagious nature of GPU from a global perspective.

Possible justifications for GPU transmission to happen through the mechanism of information flows follow. In today's predominantly globalized world, countries are becoming increasingly interdependent. Global information flows also reflect increasing international interdependence (Mowlana, 1997). As global information flows are likely to surge even future (Beiser, 2011), so are those of GPU. Besides, advances in information technology, mainly the internet and, recently, social media networks, such as Twitter, Facebook, and You-Tube, have contributed to the speed and scale of information transmission. These technological developments would also contribute to expediting GPU transmission. Another mechanism suggested in the literature is emulation; that is, people learn from the information about foreign conflicts and try to emulate those conflicts in their own countries (Hill & Rothchild, 1986; Hill, Rothchild, & Cameron, 1998). The process of emulation generates more GPU in national territories and tends to amplify GPU transmission. There is also a fear or concern mechanism. People tend to become increasingly concerned or fearful after receiving information about domestic or international conflict breakouts. The increased suspicion and mobilization trigger conflicts with wider repercussions (Kuran, 1998), which further amplifies the transmission of GPU.

Ascertaining and explaining GPU transmission is crucial for a practical reason: that is, to devise international risk management strategies and national security policies. Several geopolitical events and international reports[8] repeatedly highlight the concerns among policymakers, investors, and corporate managers about the contagious nature of GPU. Suárez-de Vivero and Mateos (2017) offers a good collection of such reports that emphasize on this issue. By summarizing these documents, the authors caution that GPU concerns are set to grow in the future, with much broader ramifications for countries, businesses, and individuals. In particular, the following trends of widespread and long-term nature are emerging about GPU. First, international governance is becoming weaker, and power is shifting from traditional state actors to non-state actors; this may lead to a global crisis. Second, increasing national sentiment is fueling extremism among the public. Third, the internal and external threats are mounting due to the spread of extremist ideologies. Finally, the proliferation of weapons of mass destruction is changing the geopolitical landscape of the world. These trends, which are associated with GPU, are destined to increase GPU transmission on a global scale. Suárez-de Vivero and Mateos (2017) also note the growing importance of cross-country consequences of GPU for investors, corporate managers, and policymakers. In particular, financial corporations and insurance sectors make use of the GPU information in their analytical forecasts. Central banks, business investors, and newspapers also regard GPU as an essential ingredient[9] of investment and policy decisions (Caldara & Iacoviello, 2018). Therefore, understanding cross-

[8] See Global Risks Reports of 2018 and 2019; World Economic Outlook, October 2017, and Economic Bulletin, March 2016, published by the World Economic Forum, International Monetary Fund, and European Central Bank, respectively. These reports highlight the growing importance of GPU and its transmission.

[9] Caldara and Iacoviello (2018) refers to two separate surveys, one conducted by Bank of England and another by Wells Fargo/Gallup in 2017, which highlight growing concerns among investors, manager, and policy makers about GPU.

country links of GPU is vital to investors, corporate managers, and policymakers for mainly predicting, and as a result, managing, and avoiding geopolitical surprises. In this way, businesses take steps to manage their credit risk, build resilient supply chains, develop crisis response plans, and secure credit and political risk insurance to protect their assets better.

Understanding the transmission GPU is also necessary to fill a theoretical void, for the topic has received limited attention in the geopolitical conflict literature. While GPU is an essential attribute of geopolitical conflicts, this literature generally overlooks the role of GPU when explaining or predicting the spread of such conflicts. Studies often explain how a geopolitical conflict undergoes a spread, diffusion, or contagion in its physical form (Blomberg & Rosendorff, 2006; Braithwaite, 2010; Buhaug & Gleditsch, 2008; Salehyan & Gleditsch, 2006). Other hold flows of media information responsible for those physically transmitted conflicts (Beiser, 2013; Hill & Rothchild, 1986; Weidmann, 2015). Many also aim to predict single geopolitical conflicts such as interstate wars (Beck, King, & Zeng, 2000; Ward, Siverson, & Cao, 2007), civil wars (Ward, Greenhill, & Bakke, 2010), geopolitical tensions (Chadefaux, 2014) or other political unrests like state failures, human rights violations, ethnic conflict, genocide, political instability (De Mesquita, 2010; Gleditsch & Ward, 2013; Schneider, Gleditsch, & Carey, 2010). Some focus on predicting the evolution of a specific conflict (Pevehouse & Goldstein, 1999; Schrodt & Gerner, 2000).

The previous studies also come with some other limitations. First, while explaining the spread of geopolitical conflict, the studies generally look at the physical spread of a conflict occurring in the form of events, not in the form of information. They often rely on event-based data, which works well in hindsight but contains a limited predictive value. Second, they typically rely on single or individual conflicts while ignoring the possibility of multiple conflicts occurring at the same time. In reality, however, many geopolitical conflicts happen simultaneously and are often interlinked. Studies aiming to predict geopolitical conflicts also ignore this possibility. Finally, the studies that rely upon news-based measures for conflict prediction often end up providing dichotomous or probabilistic forecasts about a single conflict under study. Binary predictions are criticized for producing black-and-white forecasts on geopolitical conflicts, which are otherwise continuously occurring phenomenon. Probabilistic predictions (Chadefaux, 2014), on the other hand, are fraught with imperfections in datasets that they are based on.

Some studies emphasize only on specific regions, like Central Africa, and use historical analysis of the regional geography (for instance, Huff & Lutz, 1974). This kind of analysis is highly subjective and calls for an appeal to a robust statistical method. Furthermore, Central Africa may have been critical in the 1970s; lately, however, GPU concerns have become progressively rampant across many regions of the world, and this trend is not likely to subside soon. Studying GPU transmission, with a robust statistical appeal, for those regions thus has become more relevant now.

This essay invokes a statistically sophisticated approach, the spillover model of Diebold and Yilmaz (2012), for examining GPU transmission across 19 countries. Total and pairwise GPU transmissions are estimated using this approach. The spillover framework of Barunik and Krehlik (2018) is further used to explore if the results hold for short- and long-term GPU transmissions. Diebold and Yilmaz (2012)'s model has several advantages. First, the method is simple to compute as the results of variance decomposition do not hinge on the sequence of variables. Second, the measure is tractable as it allows for the measurement of spillovers across multiple data series and therefore captures the GPU spillovers from one country to multiple countries and vice versa. The application of the model shows a substantial amount of total and pairwise GPU transmission across our sample countries, with some countries and regions experiencing more pronounced GPU transmission than others. A graphic description of the pairwise GPU transmission results using spring graphs is made from Gephi, which is an open-source, highly interactive, and user-friendly software that allows for discovering and visualizing network patterns among data. From this graph, there emerges a clear geographical clustering amongst our sample countries, which further invites us to explain the GPU transmissions between a pair of countries. Motivated by a gravity model framework, these pairwise GPU transmissions are subjected to a cross-sectional regression. Bilateral factors, such as bilateral trade, border sharing, and common distance, play an essential role in transmitting GPU shocks from one country to another. The pairwise GPU transmission is positively associated with both countries' debt burdens and the transmitting country's fiscal imbalance and geographical size. The essay subsequently uses the spillover model of Barunik and Krehlik (2018) and find that, overall, short- and long-term transmissions of GPU behave in a somewhat similar way. However, this exercise unveils following additional features: 1) the total and pairwise amounts of short-term GPU transmission is remarkably higher than that of its long-term counterpart but smaller than the overall GPU transmission computed earlier, implying that GPU transmission becomes weaker from overall to short-term to long-term; 2) the role of bilateral and country-specific factors also become less critical with the weakening level of GPU transmission; 3) while geographical proximity (border sharing and common distance) proves to be an essential determinant of overall and short-term GPU transmissions, it turns out to play no role in driving their long-term counterpart.

This essay offers the following contributions to the literature. First, the essay proposes another perspective by studying the transmission of GPU in the form of information flows that are associated with geopolitical conflicts, which is in contrast to the previous studies that have so far been considering the role of information flows in spreading physical conflicts (Beiser, 2013; Hill & Rothchild, 1986; Weidmann, 2015). In other words, the essay specifically views this information content to carry GPU across borders. Second, since the primary focus of the essay remains on the factors that can determine the amount of GPU transmission, one may be tempted to use these factors to forecast the course of GPU from one country to another. While the factors pointed out in this essay might prove helpful in such forecasting endeavors, a caution is in place that the factors may not be useful in making predictions about actual, physical conflicts. This objective may be better achieved by referring to the interstate-conflict literature that offers dichotomous or probabilistic predictions about specific conflicts, and, sometimes, aims to drive conditions that are most conducive to the conflicts (Fearon & Laitin, 2003; Glaser, 2000; Huth, 2009; Powell, 2004). Third, instead of using a latent variable such as cross-country events that could denote information transmission, this essay involves actual information flows by involving news-based GPU indices introduced by Caldara and Iacoviello (2018). By overcoming the data imperfections found in Chadefaux (2014), the GPU indices ought to improve the reliability of GPU transmission. Furthermore, in contrast to the previous study, which aimed to predict wars by relying on a measure of geopolitical tensions, this essay indicates bilateral linkages and country-specific factors that may help to explain GPU transmission. Fourth, this essay builds upon Huff and Lutz (1974) by applying a robust statistical analysis to a sample of 19 countries, other than Central Africa. Finally, the essay points towards a new type of informational spillover, i.e., GPU spillover, apart from the ones already introduced by literature (Balli et al., 2015; Balli et al., 2017; Fidrmuc & Karaja, 2013).

This essay includes the following sections: Section 2.2 lays out the methodological details and dataset. Section 2.3 reports empirical results and discussion. Section 2.4 concludes.

2.2 Data and methodology

2.2.1 Dataset

As mentioned above, the monthly series of the newly constructed GPU indices (Caldara & Iacoviello, 2018) for 19 countries are used in this investigation. The GPU index data are obtained from the economic policy uncertainty website[10] over a period from January 1985 to December 2017. Based on the availability of data, the following countries are included in our sample: Argentina, Brazil, China, Colombia, India, Indonesia, Israel, Korea, Malaysia, Mexico, Philippines, Russia, Saudi Arabia, South Africa, Thailand, Turkey, Ukraine, the United States, and Venezuela. Data on bilateral and country-specific factors, considered as potential determinants of pairwise GPU transmission, are also collected over the same period. The bilateral factors include bilateral trade, colonial ties, contiguity, common language, and geographical distance between the two countries. The country-specific factors are the central government's debt, budget deficit, stock market capitalization, and the geographical area of each country. The appendix (Table 2-7) provided at the end of the essay describes these variables along with their data sources.

The choice of GPU indices is made for the following reason. Existing GPU proxies lack certain features that a GPU indicator should have in order to be used for the measurement of GPU transmission. A GPU index equipped with these features broadens the scope of GPU transmission by enabling us to capture geographically broad, historically long, and sufficiently frequent interactions among GPUs of multiple countries. In general, other indicators that may

[10] The website, http://www.policyuncertainty.com, contains other component indices for the US such as GPU_threat, GPU_act, GPU_narrow, GPU_broad, GPU_nuclearthreat etc. However, we used the 'benchmark' index for the country in our analysis.

have served as a proxy for GPU are fraught with limitations of geographic scale, history, and coverage. Besides, these proxies are hard to quantify and rely on single wars or hindsight and thus fail to capture equally important instances when peace prevailed instead of war (Leetaru, 2011). Besides, while some indicators are less frequent and thereby fail to track or anticipate mounting tensions and conflict outbreaks in shorter periods (Beck et al., 2000; Beck, King, & Zeng, 2004; De Marchi, Gelpi, & Grynaviski, 2004; Gleditsch & Ward, 2013), others are merely not standardized, which makes them incomparable across countries. Another critical issue with the existing GPU proxies (such as political unrest, war, conflict) is that they reflect a rather narrow view of GPU. In contrast, GPU is a concept with a much broader scope surrounding all sorts of geopolitical conflicts. Thus, a GPU measure capable of overcoming these limitations would enable us to capture the dynamics of cross-country GPU transmission better.

The GPU[11] measure of Caldara and Iacoviello (2018) is the one that overcomes these shortcomings. The GPU index is constructed from news information[12] generated by the fast and accurate coverage of GPU-related stories around the world, meaning the index is an accurate and rapidly up-to-date measure of GPU. The index also avoids the problem of hindsight by reflecting the most recently published news content. Since newspapers have a significant advantage over the event-based data, they can report GPU even when no actual events take place. The GPU index is, thus, not only a robust measure of GPU but also carries a better predictive content. This index is sufficiently broad in terms of geographic and historical coverage as it offers more-frequent, long term, GPU-series for many countries; the monthly GPU series is available for 19 countries from 1985 to date. The more the data on GPU available,

[11] The GPU index is constructed by counting the occurrence of words related to GPU in leading international newspapers (Caldara & Iacoviello, 2018).
[12] Since the media content carries useful signals on cross-country conflicts (Deutsch, 1957; George, 1956; Hunt, 1997), the press is typically regarded as a reliable source for GPU related information.

the better it becomes to capture GPU transmission. The index is also a sufficiently broad measure of GPU because rather than tracking a single or a certain kind of conflict, it captures news information on multiple conflicts at the same time. Thus, the GPU indices used in this essay broaden the scope of GPU transmission by allowing for fluctuations in GPU within and across countries, and hence ensuring reliable inferences and better insights into the (cross-country) effects exerted-a point that is owed to Caldara and Iacoviello (2018).

Tables 2-1 reports the descriptive statistics of monthly GPU indices. The skewness and kurtosis values indicate that most of the GPR indices are negatively (positively) skewed and fat-tailed. Moreover, the results of the Augmented Dicky Fuller unit roots test suggest that all the GPU series are stationary at level. In contrast, the Jarque-Bera test statistics indicate that all the GPU index series are not normally distributed.

Table 2-1 Descriptive statistics of GPU series

	Mean	Median	Max.	Min.	Std. Dev.	Skew.	Kurt.	J.B.	ADF
Argentina	111.85	104.23	371.01	36.40	43.62	1.43	7.03	432.96***	-8.267***
Brazil	103.94	100.35	221.41	43.02	29.99	1.01	4.59	116.99***	-6.379***
China	105.60	98.21	251.23	56.53	29.84	1.40	5.40	240.54***	-5.032***
Colombia	80.31	77.84	171.85	22.78	28.53	0.53	3.31	21.70***	-4.651***
India	93.58	85.36	247.40	45.01	29.44	2.17	9.69	1126.15***	-4.987***
Indonesia	74.52	68.64	275.94	20.20	31.86	1.49	7.34	491.68***	-3.197***
Israel	84.52	80.74	179.20	45.78	22.79	1.16	4.59	140.45***	-4.231***
South Korea	108.73	101.23	274.42	38.70	38.79	1.50	6.51	378.73***	-8.798***
Malaysia	90.11	84.17	278.88	17.49	35.12	1.68	8.34	706.90***	-7.454***
Mexico	99.08	92.55	214.35	55.03	26.08	1.20	4.74	156.12***	-5.035***
Philippines	99.28	92.50	215.54	35.25	35.52	0.81	3.35	48.67***	-4.450***
Russia	105.86	100.15	241.38	47.68	29.05	1.18	4.92	164.71***	-7.409***
Saudi Arabia	93.11	87.79	210.64	33.18	33.35	0.76	3.47	45.30***	-5.644***
South Africa	111.52	100.50	301.71	35.66	46.52	0.99	3.82	81.72***	-2.826*
Thailand	94.46	85.99	296.19	35.44	38.89	1.79	7.77	631.41***	-12.107***
Turkey	111.56	102.74	320.26	32.63	43.41	1.28	5.41	218.56***	-7.294***
Ukraine	127.38	109.84	382.87	22.18	64.83	0.99	3.70	78.79***	-3.392**
USA	85.42	66.18	545.09	23.70	63.29	3.03	16.77	4018.16***	-7.806***
Venezuela	86.28	81.92	233.48	16.38	38.83	0.90	4.29	86.85***	-4.157***

Notes: Table 2-1 shows the descriptive statistics of the GPU series (level) for emerging economies and the US. Std. Dev. stands for standard deviation, while probability corresponds to the Jarque-Bera (J.B.) test of normality. Mean, Std denotes the monthly average, standard deviation, and kurtosis. Dev., Skew., and Kurt., respectively. ADF is the empirical statistic for the Augmented Dickey and Fuller (1979) test. The significance of test statistics for J.B. and ADF is denoted by *, **, and *** at 0.10, 0.05, and 0.01 levels, respectively.

2.2.2 GPU transmissions using Diebold and Yilmaz (2012)

As our primary analysis, the spillover model of Diebold and Yilmaz (2012) is applied to measure the total and pairwise transmission of GPU across our sample countries. To further explore the short- and long-term aspects of GPU transmission, the essay relies upon the recently introduced spillover (connectedness) framework of Brunik and Krehlik (2018). Diebold and Yilmaz (2012)'s model is widely used in academic literature mainly because of the simplicity and efficiency of its estimates (see, Bubák, Kočenda, & Žikeš, 2011; Demirer, Diebold, Liu, & Yilmaz, 2018; Yilmaz, 2010). It allows for the identification of directional spillover effects across a wide range of time series, 19 GPU series in our case. With a robust statistical approach that accommodates several country-based GPU indicators across continents, the spillover model of Diebold and Yilmaz (2012) also overcomes the limitations of geographical examination of Huff and Lutz (1974). The generalized spillover index of Diebold and Yilmaz (2012) lets us define spillovers as the fractions of the H-step-ahead error variances in forecasting x_i that is due to shocks to x_j $(i \neq j)$ for $i, j = 1,2, \cdots, N$. Where x_i and x_j represent the rates of change of GPU series i and j, and N is the total number of GPU series (which are 19 in our case)[13]. They measure spillovers in a generalized VAR framework.[14]

[13] Although the GPU indices are stationary at level, we convert them into rate-of-change in order to use in the analysis.

[14] In a simple VAR framework, the results of variance decomposition and therefore spillovers are driven by Cholesky factor orthogonalization and are potentially order-dependent. However, the spillover measures based on a generalized VAR framework, the results are not order-dependent. For more details, see Koop, Pesaran, and Potter (1996), and Pesaran and Shin (1998).

Consider a covariance stationary N-variable VAR(p), $x_t = \sum_{i=1}^{p} \phi_i \, x_{t-i} + \varepsilon_t$, where x_i is the $N \times 1$ vector of the endogenous variables, $\varepsilon \sim (0, \Sigma)$ is a vector of independently and identically distributed disturbances. The moving average representation is written as $x_t = \sum_{j=0}^{\infty} A_j \, \varepsilon_{t-j}$, where the $N \times N$ coefficient matrices A_j obey a recursion of the form $A_j = \sum_{j=1}^{p} \phi_j A_{j-p}$, with A_0 being an $N \times N$ identity matrix and $A_j = 0$ for $j < 0$.

The spillovers can be defined by generalized forecast error variance decompositions of the moving average representation of the VAR model. The H-step-ahead generalized forecast error variance decomposition can be written as follow:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \, \Sigma \, e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \, \Sigma \, A_h' e_i\right)}, \tag{1}$$

where Σ is the variance matrix of the vector of errors ε. σ_{jj} is the standard deviation of the error term of the j^{th} equation, and e_i and e_j are selection vector with a value of one for the i^{th} and j^{th}elements, respectively, and zero otherwise. A_h stands for $N \times N$ matrix of moving average coefficients corresponding to lag h.

Since own- and cross-variable variance contribution shares do not sum to one under the generalized decomposition, each entry of the variance decomposition matrix is normalized by its row sum as follows:

$$\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)}, \tag{2}$$

By construction, $\sum_{j=1}^{N} \tilde{\theta}_{ij}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H) = N$.

Thus, a total spillover (TS) index can be defined as

$$TS(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{ij}(H)}{N} \times 100\,. \tag{3}$$

This index measures the average contribution of spillovers from shocks to all (other) GPUs to the total forecast error variance. Similarly, the directional spillovers (DS) transmitted by GPU i to another GPU j can be measured by

$$DS_{i\rightarrow j}(H) = \frac{\sum_{j=1,i\neq j}^{N} \tilde{\theta}_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ji}(H)} \times 100 = \frac{\sum_{j=1,i\neq j}^{N} \tilde{\theta}_{ji}(H)}{N} \times 100\,. \tag{4}$$

The results of total and pairwise GPU transmissions are shown in Table 2-1.

2.2.3 GPU transmissions using Barunik and Krehlik (2018)

This section lays out the details of the spillover framework recently introduced by Barunik and Krehlik (2018). This model is applied to check if the results of GPU transmission continue to hold once short- and long-term horizons are considered. It should be noted that when Diebold and Yilmaz (2012) quantifies transmissions (spillovers) across a set of variables – be it pairwise or total transmission – and aggregates information through frequencies, and, therefore, they completely ignore the possibility of heterogeneous frequency responses to shocks. However, one may argue that in an economic, social, and geopolitical phenomenon, of which GPU is one case, it could be of interest to assess short-, medium- or long-term transmissions rather than the transmission seen at a single frequency. Hence, the GPU transmission results may differ depending upon the frequency band at which they are computed. It may invite a further investigation into our results that are calculated through the spillover model of Diebold and Yilmaz (2012). It might, therefore, seem more appropriate to work with frequency bands. The connectedness framework of Barunik and Krehlik (2018) can be used to perform this task.

Within this framework, the term connectedness is just another name for transmissions or spillovers. By introducing the spectral representation of variance decomposition (e.g., Stiassny, 1996; Dew-Becker & Giglio, 2016), this approach is the expansion of Diebold and Yilmaz (2012). The unique feature of the Barunik and Krehlik (2018)'s approach is its potential to capture the transmission among a set of variables (over time and) across different frequencies.

In Diebold and Yilmaz (2012), generalized forecast error variance decompositions are of central importance to ascertaining the transmissions in the time domain. Similarly, in order to estimate transmissions in the frequency domain, it becomes crucial to use a spectral representation of the variance decomposition based on frequency responses. In this case, spectral decomposition methods are employed to capture the transmission relationships within the frequency domain; and this is achieved by making use of the approaches introduced by Stiassny (1996) and Dew-Becker and Giglio (2016). The frequency response function plays a central role in this framework, which can be obtained as the Fourier transform of the coefficients A_h , with $= \sqrt{-1}$, can be defined as:

$$A\left(e^{-ih\omega}\right) = \sum_{h=0}^{\infty} e^{-ih\omega} A_h \tag{5}$$

where ω denotes the frequency.

As a next step, the power spectrum $S_x(\omega)$, which indicates how the variance of x_t is distributed over the frequency components ω , is computed as:

$$S_x(\omega) = \sum_{h=0}^{\infty} E(x_t x_{t-h})\, e^{-ih\omega} = A\left(e^{-ih\omega}\right) \sum A\left(e^{ih\omega}\right) \tag{6}$$

According to Barunik and Krehlik (2018), the frequency response functions can be used to obtain the generalized variance decompositions in the frequency domain. More specifically, the generalized forecast error variance decompositions at a specific frequency ω is calculated as:

$$\theta_{ij}(\omega) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{\infty} \left(A\left(e^{-ih\omega}\right)\Sigma\right)_{ij}^{2}}{\sum_{h=0}^{\infty} \left(A\left(e^{-ih\omega}\right) \sum A\left(e^{ih\omega}\right)\right)_{ii}}, \tag{7}$$

Where at a given frequency $\omega, \theta_{ij}(\omega)$ denotes the share of the spectrum of the variable i that can be attributed to shocks in the variable j. The forecast horizon H does play a limited role in this context.

For time-domain analysis, Eq. (7) can be normalized as:

$$\tilde{\theta}_{ij}(\omega) = \frac{\theta_{ij}(\omega)}{\sum_{h=1}^{n} \theta_{ij}(\omega)}, \tag{8}$$

Importantly, $\tilde{\theta}_{ij}(\omega)$ measures pairwise connectedness from i to j at a given frequency ω and, therefore, it can be interpreted as a within-frequency causality indicator. In contrast, the above mentioned $\tilde{\theta}_{ij}(H)$ reflects pairwise connectedness from i to j for a given horizon H, so that it can be viewed as an indicator of the strength of causality exclusively in the same domain. In this regard, when Diebold and Yilmaz (2012) quantify connectedness using $\tilde{\theta}_{ij}(H)$, they focus on information aggregated through frequencies, while the possible heterogeneous frequency response to shocks is entirely ignored.

In economic and financial applications, it can be interesting to assess short-, medium- or long-term transmission rather than transmission at a single frequency. Hence, it seems more appropriate to work with frequency bands. In this setting, the accumulative transmission at an arbitrary frequency band d = (a, b) can be obtained as:

$$\tilde{\theta}_{ij}(d) = \int_a^b \tilde{\theta}_{ij}(\omega) d\omega \, , \tag{9}$$

From here, it is possible to define a variety of transmission measures in the frequency domain, which are inspired by the indicators introduced by Diebold and Yilmaz (2012) for the time domain. For example, the overall or system-wide transmission within the frequency band d can be calculated as:

$$C^d = \frac{\sum_{i=1, i \neq j}^{n} \tilde{\theta}_{ij}(d)}{\sum_{ij} \tilde{\theta}_{ij}(d)} = 1 - \frac{\sum_{i=1}^{n} \tilde{\theta}_{ii}(d)}{\sum_{ij} \tilde{\theta}_{ii}(d)} \tag{10}$$

Note that C^d close to unity implies strong transmission within the frequency band d. However, the weight of this spectral band within the aggregate transmission might be extremely low. Hence, these measures are called within measures as they describe only the transmission within a given frequency band.

According to Barunik and Krehlik (2018), to get an indicator of the contribution of a given frequency band to aggregate transmission, the within measures must be weighted. Thus, the contribution of the frequency band d to the overall or system-wide transmission can be obtained as:

$$\tilde{C}^{d} = C^{d}.\Gamma(d) \quad (11)$$

Where the spectral weight $\Gamma(d) = \sum_{ij=1}^{n}\tilde{\theta}_{ij}(d)/\sum_{i=1}^{n}\tilde{\theta}_{ij} = \sum_{ij=1}^{n}\tilde{\theta}_{ij}(d)/n$ reflects the contribution of the frequency band d to the whole VAR system, while C^{d} is the total transmission measure corresponding to the spectral band d computed according to Eq.(10). Lastly, it should be mentioned that the sum of all frequency transmission measures over disjointed intervals is equal to the original total transmission measure proposed by Diebold and Yilmaz (2012), i.e., $C = \sum_{d}\tilde{C}^{d}$.

The results of short- and long-term GPU transmission obtained through Barunik and Krehlik (2018) are given in Tables 2-3 and 2-4, respectively.

2.2.4 Graphic description

Figures 2-1, 2-2, and 2-3 provide graphic descriptions of the results shown in Tables 2-1, 2-3, and 2-4, respectively. These figures have been created with the aid of Gephi (https://gephi.github.io/), which is open-source software for network visualization.

2.2.5 Cross-sectional determinants

Once the pairwise GPU transmissions have been computed, the next task is to explain them. This is achieved by resorting to the gravity model framework. The gravity model, which was initially developed to understand the international trade linkages (e.g., Head, Mayer, &

Ries, 2010), has recently been successful in explaining the cross-country transmission of conflict and information. The basic principle of the gravity model is that the movement of people and goods between two countries is directly proportional to their respective economic masses (or income levels) and inversely proportional to their distance (Morley, Rosselló, & Santana-Gallego, 2014). Studies that have used the gravity model framework for explaining the spread of conflict are typically hinged upon an analogy between infectious disease and the spread of a conflict (Blomberg & Rosendorff, 2006; Braithwaite, 2010; Buhaug & Gleditsch, 2008). This analogy suggests that the spread of conflict varies with the degree of interaction between interacting units (usually countries). The gravity model framework captures this dyadic interaction between a pair of countries by involving each country's size and the bilateral distance between them. Assuming the same set of constraints shape the information transmission (in our case GPU transmission) associated with a conflict, one would expect closer countries to experience a higher level of the transmission than the distant ones.

The meaning of size and distance may differ depending upon the context in which they are used in a gravity model (Fidrmuc & Karaja, 2013). The distance may be interpreted as how farther or closer two countries are in terms of their bilateral linkages such as geographical proximity, cultural and historical similarity, or economic ties. Size may also refer to economic, geographic, or public (population) mass of a country.

The economic distance is measured through bilateral trade; the magnitude of bilateral trade captures how distant or close the countries are in economic terms. In literature, there is mixed evidence on the role of bilateral trade in the spread or eruption of geopolitical conflicts (see Barbieri, 1996), for a summary of the debate). Most studies support the pacific benefit of trade; that is, bilateral trade promotes peace or reduces conflict between states (Hegre, Oneal, & Russett, 2010). Others find that trade does not deter conflict (Keshk, Pollins, & Reuveny, 2004; Kim & Rousseau, 2005). Some also argue that higher trade or extensive economic interdependence increases the likelihood of interstate conflict (Barbieri, 1996; Choucri & North, 1989; Waltz, 1979). Many consider trade as irrelevant or less critical to interstate conflicts (Blanchard & Ripsman, 1994; Buzan, 1984; Levy, 1989).

The aim of this essay is not to explain the spread of physical conflict, but to see whether the pairwise GPU transmission occurring in the form of transnational information flows is affected by bilateral trade. Bilateral trade is likely to increase the transmission of GPU between the two countries. The underlying argument is that cross-border concerns among the public, businesses, and governments tend to rise when bilateral trade between the two countries increases. People immediately become concerned about geopolitical events or conflicts happening in the countries where lie their or their governments' economic interests. Because of strong trade ties between two countries, a hike in external GPU would cause concerns in the local public, increasing the GPU in the home country. In other words, GPU will transmit across trading partners because of underlying concerns (Kuran, 1998) that emerge from the recognition of mutual benefits of bilateral trade. Therefore, other things equal, one would expect a positive association between bilateral trade and pairwise GPU transmission. Bilateral trade may also foster a learning mechanism by improving the inter-state linkages, which remove the communication barriers, facilitate the flow of information, and hence lends learning to become easier. This social learning mechanism will likely stimulate the local public who will emulate foreign geopolitical conflict in the home country (Hill & Rothchild, 1986; Hill et al., 1998).

In this theoretical framework, contiguity (or border sharing) and bilateral distance represent the extent of geographical distance (or proximity) between two countries. Previously, both factors have been included in the models that explain the spread of conflicts beyond state boundaries. For instance, Buhaug and Gleditsch (2008) find that proximity to a conflict explains the spillover effect on the probability of domestic conflict onset. Similarly, Hegre et al. (2010) find that while contiguity tends to increase the spread of conflict, distance has the opposite effect. That is, the extent of proximity explains the scale of conflict spread.

Furthermore, Blomberg and Rosendorff (2006) show that distance and border significantly explain the transnational terrorism flows. Due to their significance, earlier works have proposed that both contiguity and distance between capitals cities of the two states may be used in inter-state conflict analyses (Oneal & Russett, 1999). The underlying reasons for that are simple. States sharing a border are especially vulnerable to conflicts, and non-contiguous states sharing the same region are more prone to fight than more distant states. Notably, there is no perfect correlation between distance and any dichotomous predictor contiguity. Following this literature, the variables of border sharing and bilateral distance are also included in the model. Accordingly, one would expect contiguity to increase and distance to decrease the pairwise GPU transmission. Contiguity and distance are also included in the information transmission models of Fidrmuc and Karaja (2013) and Balli et al. (2017).

Common language, colony, and common colony are used to capture the cultural and historical distance between a pair of countries. The fear or concern (Kuran, 1998) and emulation through social learning (Hill & Rothchild, 1986; Hill et al., 1998) effects may be invoked here. Accordingly, one may argue that linguistic and historical ties contribute to concern and learning, thus facilitate the transmission process. This argument is indeed plausible since Blomberg and Rosendorff (2006) found the role of common language in transmitting terrorism across countries. Thus, one would expect a positive association between pairwise GPU transmission and cultural and historical distance between the two countries.

Geographically large countries can exert their influence not only from a long distance but also across many countries simultaneously. Along with having more neighbors, such countries typically carry much broader economic and political interests. Therefore, the size of a country reflects both their ability to participate in a conflict. Literature shows that just like proximity, countries' sizes influence the likelihood of interstate conflicts (Bearce & Fisher, 2002; Hegre, 2008; Kenneth, 1962; Werner, 1999; Xiang, Xu, & Keteku, 2007). In this literature, GDP per capita or just GDP, population size, and geographical area are orthodox candidates for country size (Braithwaite, 2010; Buhaug & Gleditsch, 2008; and Hegre et al., 2010). However, only two are considered due to their relevance. The inclusion of geographical area is because GPU is intrinsically a geographic attribute of conflict, and therefore the area is vital to this examination. Following Blomberg and Rosendorff (2006), therefore, the geographical area of each country is included in the model. To represent the economic size, however, the stock market capitalization of each country is used. This is because essentially, the essay measures the information transmission of GPU, and studies have shown that stock market capitalization is more relevant when it comes to such information transmission processes (i.e., Balli et al., 2017). Economic size may also be interpreted as state capacity to deal with vexing issues. Larger economies have the resources to cope with problems. Studies also suggest that state capacity diminishes the likelihood with which states will experience new conflict (Braithwaite, 2010), implying a negative association between GPU transmission and economic size ((stock market capitalization). One would expect a positive (negative) association between area (stock market capitalization) and GPU transmission.

Finally, some studies have also associated the spread of conflict to a so-called 'bad neighborhood' effect (Iqbal & Starr, 2008). These studies typically argue that the state undergoing a range of economic, social, and political problems are likely to be contagious for their neighboring states. Countries experiencing economic problems often do poorly while managing fiscal balance and foreign debt. Alongside, Balli et al. (2017) find that fiscal imbalances and financial liabilities of the countries are responsible for cross-country information spillovers associated with economic policy uncertainties. Combining these two notions, one may argue that fiscal imbalance and foreign debt of each country increases the pairwise GPU transmission. That is why the central government's debt and fiscal imbalance (i.e., budget deficit) are added in the model.

Considering the abovementioned factors as possible determinants of pairwise GPU transmission, this essay hypothesizes that this transmission is determined by bilateral factors such as bilateral trade, common language, colonial ties, and geographical proximity, and country-specific factors, namely fiscal imbalances, debt burdens, stock market capitalizations[15]. The following cross-sectional regression may express this relationship;

$$DS_{ij} = \alpha_o + \alpha_1 Log(Exports_{ij} + Imports_{ij}) + \alpha_2 Contiguous_{ij} + \alpha_3 Colony_{ij} + \alpha_4 Common\ Colony_{ij} + \alpha_5 Common\ Language_{ij} + \alpha_6 Log(Distance_{ij}) + \beta * X_{i\ and\ j} + \epsilon_{ij} \quad (12)$$

where DS_{ij} represents the amount of GPU spillover from $Country_i$ to $Country_j$. $Log(Exports_{ij} + Imports_{ij})$ is an indicator of bilateral trade between country i and country j. $Contigous_{ij}$ is a dummy variable representing whether or not two countries share borders. $Colony_{ij}$ and $Common\ Colony_{ij}$ are two dummies indicating colonial dependence and whether both countries have remained under the same colonial power, respectively.

[15] Some of these factors such as common language and geographical proximity were also suggested by the Emerging Risk Report (2016), produced by LLOYD'S, in their 'framework for understanding the emergence and spread of civil unrest'.

$Common\ Language_{ij}$ is a dummy variable for common language and $Log(Distance_{ij})$ is the logarithm of the distance between the capital cities of two countries. $X_{i\ and\ j}$ contains country-specific factors, namely budget deficit, central government debt, geographical area, and stock market capitalization of both countries. The results of the crossectional regression (Eq. (12)) are presented in Table 2-2.

2.3 Results and discussion

2.3.1 Total and pairwise GPU transmission

The results obtained through the spillover model of Diebold and Yilmaz (2012) are presented in Table 2-2. The table provides the estimates of GPU spillovers each country receives from (rows) and transmits to (columns) another country. The table also shows the total GPU spillovers each country transmits to all other countries (to others), as well as those each country receives from all other countries (from others). Finally, the table also includes the amounts of the total (or system-wide) mean spillovers.

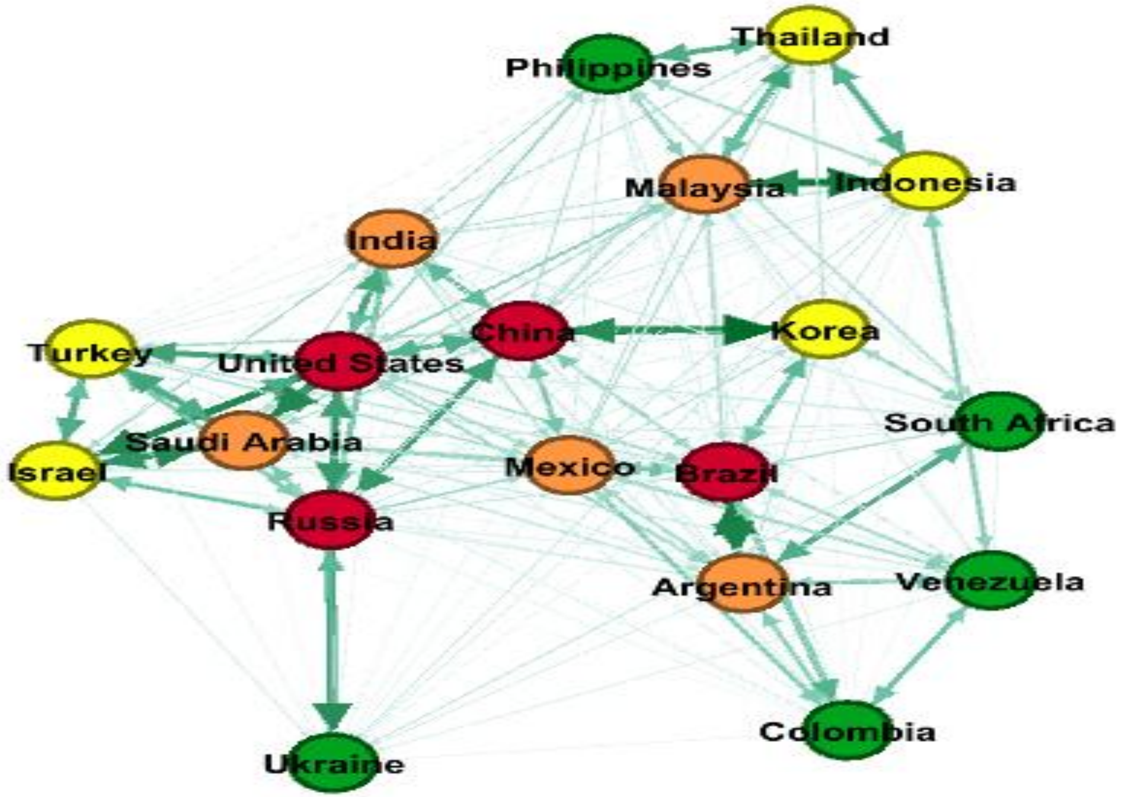
Table 2-2 offers several key features of the GPU transmissions. First, the table indicates that the total mean spillover is about 39%. Second, in general, countries that transmit more spillovers to others are also the ones that receive more, while the amounts of transmission are slightly higher than those of reception. In particular, the US (69), Russia (55), Brazil (56), China (57), and Saudi Arabia (48) are amongst the highest contributors to the forecast error variance of the remaining countries. In contrast, the US (57), Russia (49), Brazil (50), China (53), and Saudi Arabia (50) are also the leading receivers of forecast error variance from the remaining countries. Third, countries with larger geographical sizes are mainly responsible for the highest amount of GPU spillovers. Note that the countries listed above are also the ones with a larger geographical size.

Table 2-2 Total directional spillovers of GPU

	Argentina	Brazil	China	Colombia	India	Indonesia	Israel	Korea	Malaysia	Mexico	Philippines	Russia	Saudi Arabia	South Africa	Thailand	Turkey	Ukraine	United States	Venezuela	From Others
Argentina	55.93	9.16	1.35	4.15	1.57	0.70	0.73	1.76	1.23	3.21	0.44	1.44	2.19	6.43	0.09	1.29	1.10	3.44	3.81	44.07
Brazil	9.45	49.64	3.61	3.66	2.38	1.40	0.78	4.92	2.46	5.10	0.82	1.62	2.89	2.22	0.44	2.20	0.28	3.01	3.12	50.36
China	1.35	4.35	47.38	0.63	5.55	0.19	1.58	8.55	1.99	4.69	1.85	7.32	2.47	0.54	1.96	2.85	0.32	6.40	0.04	52.62
Colombia	3.84	6.14	0.55	72.75	1.45	0.34	0.15	0.20	0.20	4.46	0.91	0.78	1.04	0.53	0.16	0.32	0.13	0.94	5.11	27.25
India	0.54	1.96	5.67	0.47	63.23	1.29	2.62	0.20	1.79	2.19	2.24	4.69	1.80	1.06	1.64	0.85	0.02	6.77	1.00	36.77
Indonesia	1.07	1.75	0.18	0.57	2.68	62.43	0.45	0.94	9.72	1.52	2.89	0.76	0.72	0.49	6.30	0.46	1.39	1.40	4.25	37.57
Israel	0.91	0.97	1.46	0.23	2.61	0.29	59.31	0.36	0.73	1.33	0.76	5.23	8.09	0.69	0.07	6.48	1.01	8.86	0.60	40.69
Korea	1.92	5.78	10.54	0.18	0.18	0.88	0.35	66.36	1.69	2.16	0.94	1.29	0.26	3.09	1.90	0.15	1.01	1.07	0.24	33.64
Malaysia	1.03	2.94	2.19	0.34	2.14	8.87	0.69	2.03	57.97	1.98	3.95	1.17	2.44	1.24	5.32	0.86	0.29	3.59	0.96	42.03
Mexico	3.11	4.48	4.78	3.10	2.69	1.59	0.95	2.03	1.78	56.20	1.22	3.07	2.79	0.96	2.20	2.71	0.53	3.04	2.75	43.80
Philippines	0.81	1.15	2.19	1.14	2.24	3.82	0.78	1.48	3.06	1.41	67.20	0.83	0.70	2.56	6.52	0.49	0.03	3.02	0.57	32.80
Russia	1.09	1.34	7.79	0.59	5.54	0.83	3.50	1.01	1.13	2.36	0.24	51.17	3.14	0.28	1.29	4.20	5.78	7.73	1.00	48.83
Saudi Arabia	1.90	3.26	2.83	0.62	2.51	0.43	8.66	0.80	2.10	4.19	0.30	4.53	50.38	0.57	0.11	6.57	0.04	8.82	1.40	49.62
South Africa	6.02	2.81	0.56	0.09	1.84	0.06	0.97	4.01	0.53	1.40	2.92	0.46	1.71	71.65	0.60	0.44	1.51	1.63	0.79	28.35
Thailand	0.13	0.58	3.02	0.42	2.26	6.14	0.21	1.87	7.05	2.36	6.08	1.19	0.54	0.71	66.41	0.27	0.26	0.41	0.10	33.59
Turkey	1.15	2.07	2.99	0.07	0.76	0.53	5.36	0.44	0.98	2.53	0.12	5.50	7.04	0.83	0.54	61.16	0.61	7.22	0.12	38.84
Ukraine	0.78	0.68	0.71	0.73	0.88	1.05	1.53	0.82	0.31	0.80	0.13	8.49	0.46	1.70	0.42	0.82	78.35	0.26	1.10	21.65
United States	2.86	2.82	6.16	0.47	5.41	1.25	6.56	0.92	3.11	2.79	2.16	7.34	7.47	1.00	0.47	5.45	0.11	42.71	0.93	57.29
Venezuela	5.09	3.69	0.06	4.36	1.80	3.74	0.32	0.69	1.37	4.05	0.61	0.08	1.96	0.68	0.28	0.04	0.31	1.29	69.60	30.40
To Others	43.07	55.93	56.61	21.80	44.48	33.39	36.20	33.02	41.22	48.50	28.59	55.77	47.73	25.57	30.33	36.43	14.75	68.92	27.88	**39.48%**

Notes: The spillover model of Diebold and Yilmaz (2012) has been used to calculate these GPU spillovers, without considering any frequency bands. The sample is from January 1985 through December 2016, and the predictive horizon is 12 months. The ij-th entry of the upper-left 19 × 19 country submatrix gives the ij-th pairwise directional spillover, i.e., the percent of 100-months-ahead forecast error variance in GPU of country i due to shocks from GPU in country j. The rightmost (From Others) column gives total directional spillover (from); i.e., row sums (from all others to i). The bottom (To Others) row gives total directional spillover (to); i.e., column sums (to all others from j). The bottom-right element (in boldface) is total spillover (mean ‘‘from’’ spillover, or equivalently, mean ‘‘to’’ spillover).

Figure 2-1Total pairwise directional spillovers of GPU (Spring Graph)



Notes: The Spring Graph presented in Figure 8-1 shows the total pairwise (static) GPU spillovers among sample countries presented in Table 2-1. The colors of nodes (circles) are in the following order: green (25th percentile), yellow (50th percentile), orange (75th percentile), and red (> 75th percentile). There are two aspects to the pairwise "To Others" spillovers i.e., the width and the shade of the arrow. The wider and darker arrow represents higher pairwise "To Others" spillovers.

Fourth, a higher amount of spillover is observed among countries that are situated in the same geographical region, with some exceptions, of course. For neighboring countries (which share borders), the amount of GPU transmission is even higher. In general, the closer (farther) the countries, the higher (lower) the amount of spillover amongst them. Interestingly, however, India has higher spillover with USA compared with China; similar is the case for Israel and the USA. This perhaps boils down to the stronger geopolitical linkages between the US and India (Brazil). This finding might be driven by the overwhelming exposure of those countries' geopolitics to US GPU which seem to matter more for those countries' GPU. This could be particularly true for Israel, whose geopolitical synchronicity or close linkages with the US are well known. As the key allies of the US in South East Asia and the Middle East, India and Israel are potentially more vulnerable to GPU with the US. Another reason might be that both India and Israel have a considerably higher degree of bilateral trade with the USA as compared with China. Studies suggest that the presence of trade and geopolitical linkages between countries generate familiarity among their publics and thereby induce newspapers to follow stories of countries where the general public is interested (Hill & Rothchild, 1986; Hill, Rothchild, & Cameron, 1998). That might be the reason why trading partners in our sample have a higher magnitude of pairwise spillovers between them.

Figure 2-1 exhibits a graphic description of the critical observations taken from Table 2-1. The figure shows a static (full sample) network graph of mean spillovers. It is evident from the figure that most of the countries in the same geographical region are clustered around each other, meaning there is a higher amount of GPU transmission amongst them. It is typically the case for Southeast Asia, Latin America, East Asia, Gulf, and East European Plain. However, the number of countries and the extent of transmission (i.e., the closeness) within a cluster varies across clusters. In particular, the number of countries within a cluster range from five

(Brazil, Argentina, Mexico, Colombia, and Venezuela) in Latin America to two (Russia and Ukraine) in East European Plain; and the countries in the Middle East (Israel, Turkey[16], and Saudi Arabia) are much closer than the ones in Latin America. Also, a country with the largest geographical size within each region usually is the leading participant of GPU spillovers in that region. For instance, in Latin America, the East European Plain, and South Asia, where the leading countries, shown in 'Red' nodes, are Brazil, Russia, and China, respectively. Finally, the US is the highest participant in GPU transmission across the sample countries, as can be noted from its central location in the figure.

In passing, note that the geographic clustering is seemingly ubiquitous in the GPU transmission. It is not clear, however, whether this clustering is explained only by geographic factors or some other bilateral and country-specific factors also determine it. To this end, this essay proceeds further and digs deeper into the cross-country GPU transmissions. As motivated earlier, bilateral and country-specific factors can explain this transmission. The pairwise GPU transmissions are therefore subjected to a cross-sectional regression based on the gravity model framework.

2.3.2 Determinants of GPU transmission

Table 2-3 includes the coefficient estimates of the determinants of pairwise GPU transmission, DS_{ij}. Notice that GPU spillover from a $Country_i$ to another $Country_j$, DS_{ij} , in Eq.(4) is the dependent variable in Eq. (12). Note also that while $Country_i$ is the transmitter of GPU shocks, $Country_j$ is the receiver of those shocks. Column (1) of Table 2-3 includes estimates of the gravity model with bilateral linkages, while column (2) shows estimates of the

[16] For the sake of grouping, we consider Turkey as part of Gulf region, because being a Muslim country it may be affected more by the GPU of Israel and Saudi Arabia than other countries, except the US, in the sample.

gravity model (extended), which incorporates country-specific variables. As motivated in the abovementioned methodology section, it is conjectured that bilateral linkages and country-specific factors included in the Eq. (5) maybe the possible determinants of DS_{ij}.

Table 2-3 Determinants of pairwise GPU transmissions (DS_ij)- estimated using Diebold and Yilmaz(2012)

Variable	*Gravity Model* (1) *Total*	*Gravity Model (Extended)* (2) *Total*
Intercept	*5.430**** *1.69*	*-3.167* *2.359*
Log(Exports$_{ij}$ + Imports$_{ij}$)	*0.274**** *0.05*	*0.384**** *0.073*
Contiguous$_{ij}$	*1.724**** *0.484*	*1.540*** *0.64*
Colony$_{ij}$	*0.321* *0.973*	*0.322* *0.921*
Common Language$_{ij}$	*0.535* *0.343*	*0.508* *0.43*
Log(Distance$_{ij}$)	*-0.816**** *0.153*	*-0.500**** *0.186*
Budget Deficit$_i$		*0.102** *0.059*
Budget Deficit$_j$		*0.07* *0.059*
Debt$_i$		*0.017*** *0.008*
Debt$_j$		*0.016*** *0.008*
Log(Area$_i$)		*0.196*** *0.075*
Log(Area$_j$)		*0.08* *0.075*
Log(Market Capitalization$_i$)		*-0.086* *0.213*
Log(Market Capitalization$_j$)		*-0.206* *0.213*
R^2	*30.30%*	*37.67%*
Total Observations	*342*	*342*

Notes: The table reports the results of cross-sectional estimation with HAC standard errors in parentheses. *, **, and *** indicate the significance of t-statistics at 10%, 5%, and 1% levels respectively.

Column (1) and (2) show that bilateral trade and geographical proximity (contiguity and bilateral distance) significantly explain the pairwise transmission of GPU. In column (1), bilateral trade is a significant determinant of the pairwise GPU transmission at the 1% level. A

1 % increases in $Exports_{ij} + Imports_{ij}$ increases DS_{ij} by 0.0027%[17]. This impact increases slightly to 0.0038 % in column (2). Economically, this finding implies that bilateral trade between the two countries is a significant and positive driver of GPU transmission between them. Contrary to the pacific advantages of trade documented by some interstate conflict studies, this finding suggests that bilateral trade increases the transmission of GPU between trading partners. One possible explanation of this phenomenon may be attributed to the familiarity effect suggested by some earlier studies, according to which the general public of the trading partners becomes more acquainted with each other's countries. Accordingly, the public becomes more informed about geopolitical affairs by closely watching each other, and thus the newspapers begin to report cross-country news, leading to the transmission of GPU across trading partners. Border sharing is also a significant driver of DS_{ij}. In column (1), the coefficient of $Contigous_{ij}$ implies that at 1% level of significance and on average, a $Country_i$ that shares a border with another $Country_j$ transmits 1.7240% higher amount of DS_{ij} to the $Country_j$ than a comparable country that does not share a border. This coefficient reduces slightly to 1.5410% in column (2) at 5% significance level. Bilateral distance is negatively associated with DS_{ij} at 1% significance level. A 1% increase in $Distance_{ij}$ decreases DS_{ij} by 0.0082% in column (1) and by 0.0050% in column (2).

These findings suggest that the extent of economic distance (bilateral trade) and geographical proximity (bilateral distance and border sharing) mainly determines the magnitude of GPU transmission between the two countries. The finding that bilateral trade causes GPU to transmit across countries confirms the previous finding that trade or extensive economic interdependence increases the likelihood of interstate conflict (Barbieri, 1996; Choucri & North, 1989; Waltz, 1979). The increased GPU transmission because bilateral trade

[17] Because of their smaller size, the coefficients are reported up to four decimal places.

reflects this increased likelihood of conflict between trading partners. Higher bilateral trade also implies more substantial economic interdependence between states. This interdependence may cause violence or unrest in one country to spill over to the countries' stronger trade ties. It may destabilize trade and economic relations, provoke distressed migrations, and lead to complex humanitarian disasters in the other country. These are all various forms of geopolitical conflicts that lead to GPU. This was obvious when GPU emerging from Syria spread to neighboring countries such as Turkey, causing or multiplying disruptions in those countries' geopolitical landscape. Hence, the finding on bilateral does not support the pacific benefit of trade – which means that bilateral trade promotes peace by reduces conflict (Hegre et al., 2010). However, cultural and historical distance (colonial ties and language similarity) are not found relevant to this transmission. That may be because of sample limitations. Only a few countries in our sample have similar languages. Even a smaller number of countries have colonial tries. It is thus not clear as to whether these factors explain GPU transmission. Although one would still expect the relationship, a different dataset, such as Europe, may help to capture this relationship.

Our findings on geographical proximity confirm Blomberg and Rosendorff (2006), which provides evidence that distance and border significantly explain the transnational terrorism flows. These findings also corroborate with those on the spread of a physical conflict (Buhaug & Gleditsch, 2008; Hegre et al., 2010; Oneal & Russett, 1999). As expected, contiguity increases while distance decreases the pairwise GPU transmission. Considering GPU transmission happening via information flows, the reader should find these results supporting Balli et al. (2015), Balli et al. (2017), and Fidrmuc and Karaja (2013). Overall, it implies that geographical proximity facilitates the transmission of GPU. However, these findings contradict the view of Virilio (1986), who suggested that territory has lost its significance and that speed has become more critical in geopolitics than the place.

Column (2) shows that country-specific (or domestic) attributes also play an important role in the pairwise GPU transmission. At a 10% significance level, the budget deficit (or say fiscal imbalance) of $Country_i$ is an important factor in explaining DS_{ij}. Keeping other factors constant, a 1%[18] increase in the country's budget deficit increases DS_{ij} from $Country_i$ to $Country_j$ by 0.1020%. This indicates that a transmitter country's widening fiscal imbalance increases the GPU transmission from this country. However, the relationship between a receiving country's fiscal imbalance, i.e., $Country_j$, and GPU transmission is not found significant. Central government's debts of both countries also appear to be an important factor in the pairwise GPU transmission. A 1% (as a percentage of GDP) rise in $Debt_i$ produces an increment of 0.017% in DS_{ij} at a 5% significance level. Likewise, a 1% increase in $Debt_j$ increase DS_{ij} by 0.016% at 5% level. This suggests that both countries' rising debt levels not only increase the transmission of GPU shocks from them but also the reception of the shocks coming towards them.

The results on fiscal imbalance, as well as central government debt, indicate the existence of the bad-neighborhood effect, which is consistently found in the interstate conflict literature; see Iqbal and Starr (2008), for instance. Consistent with their argument, the findings of this essay suggest that states undergoing economic problems will likely be contagious to their neighbors. Although these findings pertain to information spillover of GPU, they might also be considered supporting Balli et al. (2017) that fiscal imbalances and financial liabilities

[18] Note that budget deficit, debt (central government debt), and market capitalization of each country have been measured as a percentage of gross domestic product (GDP) of the respective country.

of the countries are responsible for cross-country information spillovers of economic policy uncertainty.

Since the notion of geopolitics, and therefore GPU, is inherently linked to geography, the results on geographical size (area) shown in Column (2) are of critical importance. See that geographical size of country i, denoted by $Log(Area_i)$, significantly determine the pairwise GPU transmission. The coefficient of $Log(Area_i)$ in column (2) means that a 1% rise in $Area_i$ produces an increment of 0.02% in DS_{ij} at 5% significance level. This suggests larger the geographical size of a $Country_i$, the higher the amount of GPU shocks transmitted from the country to another. The primary examples of geographically large countries include Russia, Brazil, Saudi Arabia, and the US. The dominant role of these geographically larger countries is also evident from both Fig 2-1 and Table 2-1. In general, our findings on area corroborates with the consistent finding that countries' size influences the likelihood of interstate conflicts (Bearce & Fisher, 2002; Hegre, 2008; Kenneth, 1962; Werner, 1999; Xiang et al., 2007).

In summary, the results reveal a substantial amount of GPU transmission across the sample countries. Bilateral factors such as bilateral trade, border sharing, and common distance play an essential role in transmitting GPU shocks from one country to another. While increases in debt burden, geographical size, and fiscal imbalance of a transmitting country tend to increase the pairwise GPU transmission, a rising debt burden of the receiving country appears to exert a similar effect.

2.3.3 Short-and long-term GPU transmission effects

Although the results presented so far may seem intuitive and broadly acceptable to the general audience, they may be contested on the following ground. Historically, some counties like Russia, Saudi Arabia, Israel, China, and the United States have experienced or caused long-run effects of GPU, whereas, for other countries, GPU could be a relatively short-term phenomenon. The recent attempt of the coup in Turkey in 2016 and the military intervention in Thailand in 2014 are two examples leading to heightened GPU of the countries in the short-run. Consequently, the transmission or spillovers of GPUs for those countries may have only lasted for 1–3 months.

On the other hand, GPUs resulted from events like 9/11 in the United States, Russian Invasion in Afghanistan, and Israel and Palestine's conflict have prevailed over the long-run-in fact over decades. It may be plausible to test the transmission of GPU in the short- and long-term. That would enable us to see whether the character of GPU transmission and hence the factors affecting it change when different time horizons are considered. In other words, this will provide us a way to test our results for the short- and long-term nature of GPU.

To do this, Barunik and Krehlik (2018) offer a spillover model that allows us to estimate short- and long-term GPU transmissions. This model works with frequency bands that correspond to short-, medium-, and long-term transmissions. Considering the nature of GPU as well as the monthly frequency of the GPU series, only two frequency hands are chosen that correspond to short- and long-term GPU transmissions, respectively. The short-term spectral band refers to movements up to 3 months, while the one representing long-term corresponds to movements from 3 to more months. Antonakakis, Gabauer, Gupta, and Plakandaras (2018) and Kang, Tiwari, Albulescu, and Yoon (2019) make similar choices regarding frequency bands while working with monthly data. Following Yin & Han (2014), the static version of the model is applied by using a forecast horizon of 12 months, and the lag lengths are chosen according to the Schwartz information criterion. The estimation results for short- and long-term GPU transmission are presented in Table 2-4 and Table 2-5, while their graphic diagrams are presented in Figures 2-2 and 2-3, respectively.

Table 2-4 Short term directional spillovers of GPU

	Argentina	Brazil	China	Colombia	India	Indonesia	Israel	Korea	Malaysia	Mexico	Philippines	Russia	Saudi Arabia	South Africa	Thailand	Turkey	Ukraine	United States	Venezuela	From Others
Argentina	47.34	7.29	1.11	3.75	1.55	0.53	0.55	1.48	0.95	2.68	0.36	1.32	1.75	5.83	0.08	1.14	1.05	2.68	3.04	37.14
Brazil	8.07	41.35	3.16	2.82	2.23	1.28	0.49	4.44	2.06	4.48	0.62	1.46	2.30	1.89	0.37	1.99	0.26	2.20	2.66	42.79
China	1.16	3.97	38.61	0.61	4.97	0.16	1.46	7.24	1.67	4.15	1.58	6.11	2.07	0.51	1.23	2.50	0.18	5.22	0.04	44.84
Colombia	3.29	5.54	0.51	64.17	1.43	0.31	0.13	0.19	0.18	3.95	0.75	0.76	0.94	0.52	0.15	0.30	0.13	0.87	4.52	24.48
India	0.36	1.52	4.39	0.32	51.78	0.87	2.25	0.18	1.21	1.72	1.61	3.41	1.16	0.74	1.21	0.76	0.02	4.93	0.64	27.29
Indonesia	0.80	1.25	0.13	0.44	2.60	53.85	0.41	0.77	8.45	1.18	2.40	0.74	0.50	0.49	5.80	0.42	1.19	0.97	3.23	31.77
Israel	0.64	0.83	1.18	0.22	2.33	0.22	48.62	0.29	0.53	1.18	0.63	4.62	6.14	0.55	0.04	5.68	0.74	7.08	0.48	33.36
Korea	1.41	4.93	8.47	0.17	0.15	0.65	0.27	55.31	1.31	1.81	0.65	0.90	0.19	2.50	1.22	0.09	0.97	0.72	0.15	26.55
Malaysia	0.94	2.51	1.76	0.34	2.08	7.46	0.52	1.86	48.62	1.55	3.63	0.97	1.75	1.22	4.68	0.72	0.29	2.59	0.71	35.55
Mexico	2.58	3.45	4.19	2.53	2.51	1.43	0.64	1.86	1.38	48.03	0.89	2.70	2.11	0.78	1.90	2.40	0.41	2.30	2.23	36.26
Philippines	0.75	0.92	1.71	0.96	1.80	3.30	0.55	1.39	2.27	1.04	56.04	0.64	0.49	2.14	5.52	0.40	0.02	2.26	0.38	26.53
Russia	0.68	1.03	6.56	0.46	5.11	0.68	2.59	0.77	0.74	1.61	0.15	42.36	2.30	0.25	0.85	3.18	4.77	5.41	0.90	38.04
Saudi Arabia	1.48	2.77	2.51	0.49	2.42	0.31	7.80	0.79	1.72	3.90	0.27	4.20	42.76	0.44	0.09	5.66	0.03	7.43	1.04	43.36
South Africa	4.71	2.15	0.51	0.07	1.79	0.05	0.69	3.61	0.47	1.22	2.55	0.41	1.31	60.09	0.55	0.42	1.39	1.37	0.68	23.92
Thailand	0.09	0.35	2.72	0.42	2.02	5.44	0.19	1.69	6.40	1.74	4.88	0.95	0.54	0.45	54.48	0.26	0.15	0.33	0.08	28.70
Turkey	0.78	1.39	2.03	0.06	0.51	0.47	4.03	0.34	0.61	1.82	0.07	4.48	5.31	0.81	0.44	49.95	0.49	4.88	0.11	28.64
Ukraine	0.57	0.51	0.68	0.68	0.84	1.04	1.23	0.55	0.28	0.60	0.10	6.87	0.45	1.57	0.27	0.66	65.11	0.22	1.09	18.20
United States	2.01	2.08	4.99	0.33	4.51	0.80	4.91	0.80	2.05	2.18	1.51	5.77	5.32	0.74	0.33	4.10	0.08	32.50	0.57	43.09
Venezuela	4.21	2.70	0.06	3.21	1.72	2.89	0.31	0.67	1.03	3.49	0.48	0.07	1.57	0.55	0.25	0.04	0.29	1.00	58.28	24.55
To Others	34.55	45.18	46.65	17.88	40.55	27.89	29.02	28.91	33.30	40.29	23.11	46.39	36.19	21.99	24.98	30.72	12.46	52.44	22.55	**32.37%**

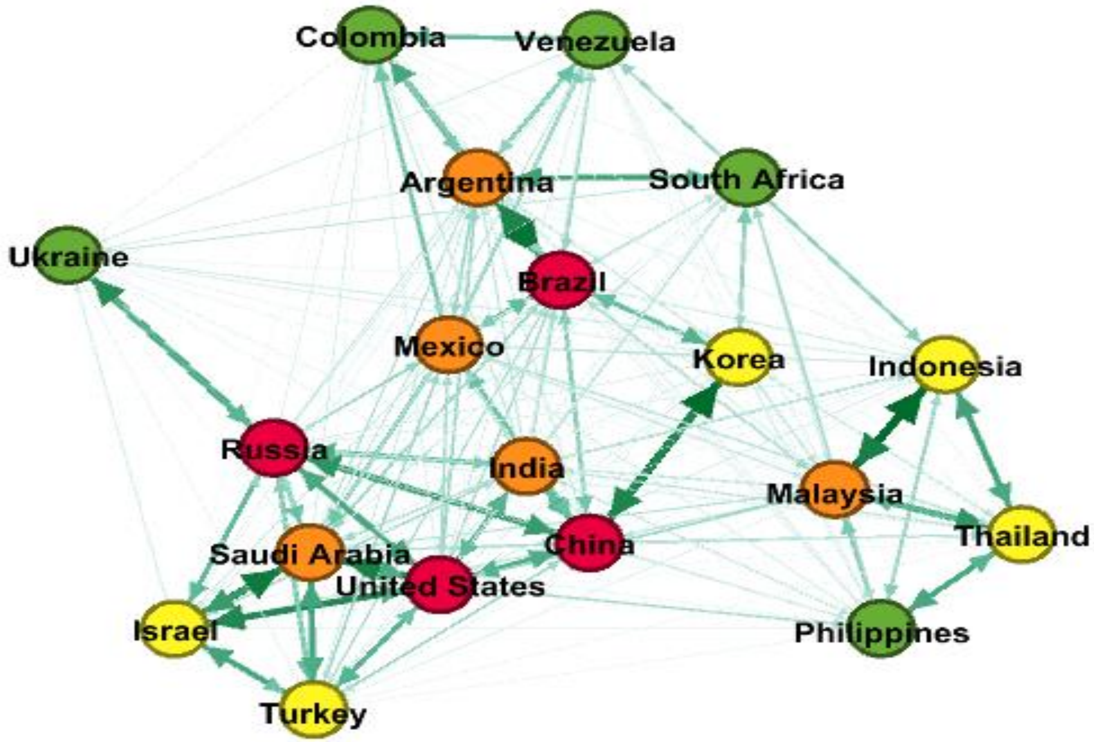
Notes: The spillover model of Barunik and Krehlik (2018) has been used to calculate these short-term GPU spillovers. The short-term spillovers correspond to the frequency band of less than 3 months. The sample is from January 1985 through December 2016, and the forecast horizon is 12 months. The ij-th entry of the upper-left 19 × 19 country submatrix gives the ij-th pairwise directional spillover, i.e., the percent of 12-months-ahead forecast error variance in GPU of country i due to shocks from GPU in country j. The rightmost (From Others) column gives total directional spillover (from); i.e., row sums (from all others to i). The bottom (To Others) row gives total directional spillover (to); i.e., column sums (to all others from j). The bottom-right element (in boldface) is total spillover (mean ‘‘from’’ spillover, or equivalently, mean ‘‘to’’ spillover).

Table 2-5 Long term directional spillovers of GPU

	Argentina	Brazil	China	Colombia	India	Indonesia	Israel	Korea	Malaysia	Mexico	Philippines	Russia	Saudi Arabia	South Africa	Thailand	Turkey	Ukraine	United States	Venezuela	From Others
Argentina	8.59	1.87	0.24	0.39	0.02	0.17	0.18	0.28	0.28	0.53	0.08	0.12	0.44	0.59	0.01	0.15	0.05	0.76	0.77	6.93
Brazil	1.39	8.28	0.45	0.84	0.16	0.12	0.29	0.48	0.40	0.62	0.20	0.16	0.59	0.34	0.07	0.21	0.01	0.81	0.45	7.57
China	0.19	0.38	8.77	0.02	0.58	0.03	0.12	1.31	0.31	0.54	0.26	1.21	0.40	0.03	0.73	0.34	0.14	1.18	0.00	7.78
Colombia	0.55	0.60	0.05	8.59	0.02	0.03	0.03	0.01	0.02	0.50	0.16	0.02	0.10	0.00	0.00	0.01	0.00	0.07	0.58	2.76
India	0.18	0.44	1.27	0.15	11.45	0.42	0.37	0.02	0.58	0.47	0.63	1.27	0.64	0.32	0.43	0.09	0.00	1.84	0.36	9.49
Indonesia	0.27	0.50	0.05	0.13	0.09	8.58	0.04	0.17	1.27	0.34	0.49	0.01	0.22	0.00	0.51	0.04	0.21	0.44	1.02	5.80
Israel	0.26	0.14	0.28	0.01	0.28	0.07	10.68	0.07	0.21	0.15	0.14	0.61	1.95	0.14	0.03	0.80	0.26	1.78	0.12	7.33
Korea	0.51	0.85	2.07	0.01	0.03	0.23	0.08	11.05	0.37	0.35	0.29	0.39	0.08	0.59	0.69	0.06	0.04	0.36	0.08	7.08
Malaysia	0.09	0.44	0.43	0.00	0.06	1.41	0.17	0.17	9.35	0.43	0.33	0.20	0.69	0.02	0.64	0.13	0.00	1.01	0.25	6.48
Mexico	0.53	1.03	0.60	0.58	0.19	0.16	0.32	0.17	0.40	8.17	0.33	0.37	0.69	0.18	0.29	0.31	0.12	0.74	0.52	7.54
Philippines	0.06	0.23	0.48	0.17	0.44	0.52	0.23	0.09	0.79	0.37	11.15	0.19	0.21	0.43	1.01	0.09	0.01	0.77	0.18	6.27
Russia	0.41	0.31	1.23	0.13	0.42	0.15	0.90	0.24	0.39	0.75	0.10	8.81	0.83	0.02	0.43	1.03	1.01	2.32	0.10	10.80
Saudi Arabia	0.42	0.49	0.32	0.13	0.10	0.12	0.86	0.01	0.38	0.29	0.02	0.33	7.62	0.12	0.02	0.91	0.00	1.39	0.36	6.26
South Africa	1.31	0.66	0.05	0.02	0.05	0.01	0.29	0.40	0.06	0.18	0.37	0.05	0.40	11.56	0.05	0.03	0.12	0.26	0.11	4.43
Thailand	0.04	0.23	0.30	0.00	0.24	0.71	0.02	0.17	0.65	0.62	1.21	0.24	0.00	0.26	11.93	0.00	0.11	0.08	0.02	4.89
Turkey	0.37	0.68	0.96	0.00	0.25	0.06	1.33	0.10	0.37	0.71	0.05	1.01	1.74	0.02	0.11	11.21	0.13	2.34	0.01	10.21
Ukraine	0.21	0.17	0.03	0.05	0.04	0.01	0.29	0.26	0.03	0.20	0.03	1.62	0.00	0.13	0.15	0.16	13.24	0.04	0.01	3.44
United States	0.85	0.74	1.16	0.14	0.90	0.45	1.65	0.12	1.06	0.60	0.65	1.57	2.15	0.26	0.14	1.35	0.03	10.22	0.36	14.19
Venezuela	0.88	0.98	0.00	1.14	0.08	0.85	0.01	0.01	0.33	0.56	0.13	0.01	0.39	0.12	0.04	0.00	0.03	0.30	11.32	5.86
To Others	8.52	10.75	9.96	3.92	3.93	5.51	7.18	4.11	7.91	8.20	5.48	9.38	11.53	3.58	5.35	5.71	2.29	16.48	5.32	**7.11%**

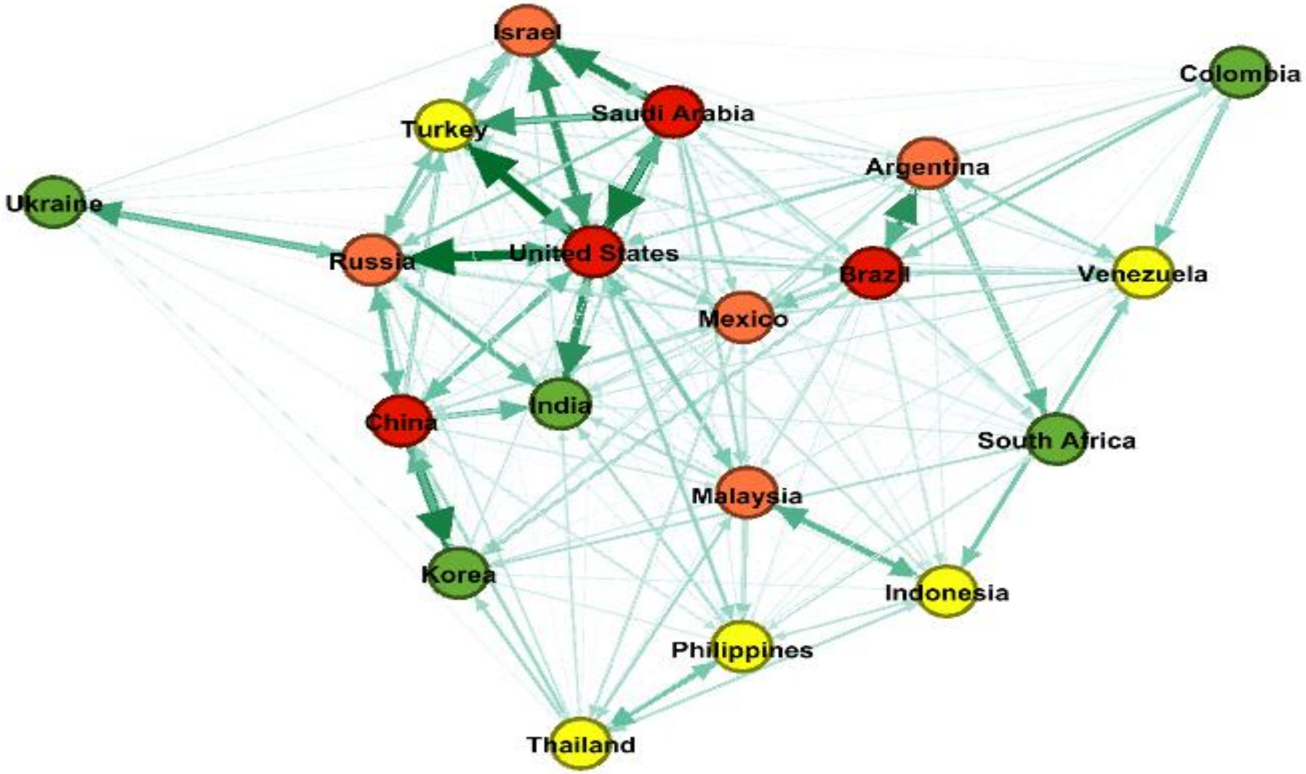
Notes: The spillover model of Barunik and Krehlik (2018) has been used to calculate these long-term GPU spillovers. The long-term spillovers correspond to a frequency band of more than 3 months. The sample is from January 1985 through December 2016, and the forecast horizon is 12 months. The ij-th entry of the upper-left 19 × 19 country submatrix gives the ij-th pairwise directional spillover, i.e., the percent of 12-months-ahead forecast error variance in GPU of country i due to shocks from GPU in country j. The rightmost (From Others) column gives total directional spillover (from); i.e., row sums (from all others to i). The bottom (To Others) row gives total directional spillover (to); i.e., column sums (to all others from j). The bottom-right element (in boldface) is total spillover (mean ‘‘from’’ spillover, or equivalently, mean ‘‘to’’ spillover)

Figure 2-2 Short-term pairwise directional spillovers of GPU (Spring Graph)



Notes: The Spring Graph presented in Figure 2-2 shows the pairwise (static) short-term GPU spillovers among sample countries presented in Table 2-3. The colors of nodes (circles) are in the following order: green (25th percentile), yellow (50th percentile), orange (75th percentile), and red (> 75th percentile). There are two aspects to the pairwise "To Others" spillovers i.e., the width and the shade of the arrow. A wider and darker arrow represents higher pairwise "To Others" spillovers.

Figure 2-3 Long-term pairwise directional mean spillovers of GPU (Spring Graph)



Notes: The Spring Graph presented in Figure 2-3 shows the long-term pairwise (static) GPU spillovers among sample countries presented in Table 2-4. The colors of nodes (circles) are in the following order: green (25th percentile), yellow (50th percentile), orange (75th percentile), and red (> 75th percentile). There are two aspects to the pairwise "To Others" spillovers i.e., the width and the shade of the arrow. A wider and darker arrow represents higher pairwise "To Others" spillovers.

In general, the key features of the short- and long-term GPU transmission that emerged from Table 2-4 and 2-5 are not much different from the ones seen in Table 2-2. Interestingly, total short-term GPU transmission (32%) in Table 2-4 is substantially larger than its long-term counterpart in Table 2-5 (7%). Also, note that the sum of these two transmissions is equal to the total GPU transmission (39%) shown earlier in Table 2-2. A higher amount of short-term GPU transmission reflects that fluctuations in GPU over 1-3 months have substantially displayed stronger contagious character compared to the movements beyond three months. Like Table 2-2, Tables 2-4 and 2-5 show that the countries that transmit more GPU spillovers to other countries are also the ones that receive more, while the amounts of transmission are slightly higher than those of reception. Concentrating on Table 2-4, for instance, the US (52%), Russia (46%), Brazil (45%), China (47%), Mexico (40%) are amongst the highest contributors to the forecast error variance of the remaining countries. Likewise, the US (43%), Russia (38%), Brazil (43%), China (45%), and Saudi Arabia (43%) are also the leading receivers of forecast error variance from the remaining countries. With a reduction in magnitude, a similar pattern is depicted in Table 2-5. Just like Table 2-2, both the tables show that countries that are bigger in geographical size are the ones with greater participation in GPU spillovers. Once again, with a few exceptions, a higher amount of spillover is generally observed among countries that are located within the same geographical region. Furthermore, the apparent patterns amongst countries for border sharing, bilateral distance, and trading behavior are also not very different from ones observed from Table 2-2.

Finally, the geographical clustering presented in Figures 2-2 and 2-3 also resembles the one depicted earlier in Figure 2-1. Overall, from the patterns shown in Tables (Figures) 2-4 (2-2) and 2-5 (2-3), one may be tempted to conclude that while the total amount of short-term GPU transmission is remarkably higher than the long-term counterpart, the other features of both transmissions remain seemingly unchanged. Nevertheless, I still need to ascertain whether this is indeed the case. The results are obtained by resorting to the cross-sectional regression described earlier by Eq. (12) and are presented in Tables 2-6 and 2-7.

Table 2-6 Determinants of pairwise GPU transmissions (DS_ij)- estimated using Diebold and Yilmaz(2012)

Variable	*Gravity Model* (1) *Short term*	*Gravity Model (Extended)* (2) *Short term*
Intercept	*4.887**** *1.405*	*-1.554* *1.976*
Log(Exports$_{ij}$ + Imports$_{ij}$)	*0.213**** *0.042*	*0.288**** *0.061*
Contiguous$_{ij}$	*1.491**** *0.402*	*1.388*** *0.536*
Colony$_{ij}$	*0.09* *0.809*	*0.101* *0.771*
Common Language$_{ij}$	*0.452* *0.285*	*0.468* *0.36*
Log(Distance$_{ij}$)	*-0.700**** *0.127*	*-0.458**** *0.156*
Budget Deficit$_i$		*0.081* *0.049*
Budget Deficit$_j$		*0.065* *0.049*
Debt$_i$		*0.012** *0.006*
Debt$_j$		*0.013*** *0.007*
Log(Area$_i$)		*0.151*** *0.063*
Log(Area$_j$)		*0.054* *0.063*
Log(Market Capitalization$_i$)		*-0.066* *0.178*
Log(Market Capitalization$_j$)		*-0.137* *0.178*
R^2	*30.11%*	*36.16%*
Total Observations	*342*	*342*

Notes: The table reports the results of cross-sectional estimation with HAC standard errors in parentheses. *, **, and *** indicate the significance of t-statistics at 10%, 5%, and 1% levels respectively.

Table 2-7 Determinants of pairwise GPU transmissions (DS_ij)-estimated using Barunik and Krehlik (2018)

Variable	*Gravity Model* *(1)* *Long term*	*Gravity Model (Extended)* *(2)* *Long term*
Intercept	*0.543*	*-1.613****
	0.353	*0.492*
Log(Exports$_{ij}$ + Imports$_{ij}$)	*0.061****	*0.096****
	0.01	*0.015*
Contiguous$_{ij}$	*0.233***	*0.152*
	0.101	*0.133*
Colony$_{ij}$	*0.23*	*0.22*
	0.203	*0.192*
Common Language$_{ij}$	*0.083*	*0.04*
	0.072	*0.09*
Log(Distance$_{ij}$)	*-0.117****	*-0.043*
	0.032	*0.039*
Budget Deficit$_i$		*0.021**
		0.012
Budget Deficit$_j$		*0.005*
		0.012
Debt$_i$		*0.006****
		0.002
Debt$_j$		*0.003**
		0.002
Log(Area$_i$)		*0.044****
		0.016
Log(Area$_j$)		*0.026**
		0.016
Log(Market Capitalization$_i$)		*-0.02*
		0.044
Log(Market Capitalization$_j$)		*-0.07*
		0.044
R^2	*23.63%*	*36.30%*
Total Observations	*342*	*342*

Notes: The table reports the results of cross-sectional estimation with HAC standard errors in parentheses. *, **, and *** indicate the significance of t-statistics at 10%, 5%, and 1% levels respectively.

Like Table 2-3, Tables 2-6 and 2-7 include the coefficients of the determinants of pairwise GPU transmission. While the independent variables – bilateral and country-specific factors shown in Eq. (12) – remain the same in both the tables, the dependent variable – the pairwise GPU transmission (DS_{ij}) – is substituted by short-term DS_{ij} and long-term DS_{ij} separately in the equation. In Table 2-6, the results for the short-term DS_{ij} are presented, while Table 2-7 contains the results for the long-term DS_{ij}. With no change in interpretations, column (1) of Tables 2-6 and 2-7 show that the coefficients of $Log(Exports_{ij} + Imports_{ij})$, $Contigous_{ij}$, $Log(Distance_{ij})$, $Debt_i$, $Debt_j$, and $Log(Area_i)$ are not only significant but also carry the same signs as those in column (1) of Table 2-3. Besides, these coefficients have become slightly weaker this time, with $Budget\ Deficit_i$ completely losing its significance. For example, a comparison of column (1) of Table 2-3 and Tables 2-6 and 2-7 shows that the coefficient of $Log(Exports_{ij} + Imports_{ij})$ reduces marginally from 0.0027 % (Table 2-2) to 0.0021 % (Table 2-5) to 0.0006 % (Table 2-7). Likewise, the coefficient of $Contigous_{ij}$ also show a slight reduction, from 1.5410% (Table 2-3) to 1.4910% (Table 2-6) to 0.2330% (Table 2-7). The coefficients of most other (significant) determinants exhibit a similar tendency. The reduction in coefficient size is also evident from columns (1) and (2) of Table 2-7.

To put things in perspective, notice that the total and pairwise GPU transmissions become weaker from Table 2-2 to Table 2-4 to Table 2-5; that is, from overall to short-term to long-term GPU transmission. Once coupled with the coefficient reduction, this may lead to the conclusion that the role of bilateral and country-specific factors becomes weaker with the lessening strength of the GPU transmission.

In column (2) of Tables 2-6 and 2-7, surprisingly, while $Log(Exports_{ij} + Imports_{ij})$ continues to drive DS_{ij}, it turns out that $Contigous_{ij}$ and $Log(Distance_{ij})$ completely lose their relevance. Besides, while the coefficient of $Budget\ Deficit_i$ gains significance this time, a new factor, namely $Log(Area_j)$, is found to be relevant. Other country-specific factors namely, $Debt_i$, $Debt_j$, and $Log(Area_i)$ also continue to be important for the long-term transmission of GPU, although with the same coefficient signs as were found in Table 2-3. Overall, the main conclusion from these findings is that the geographical proximity (border sharing and common distance) is an essential driver of overall and short-term transmission of GPU. In contrast, it plays no role in the long-term transmission of GPU. As mentioned earlier, this finding supplements Blomberg and Rosendorff (2006). Via this robustness exercise, the essay confirms that while geographical proximity drives the overall and short-term transmission of GPU, this driving vanishes for the long-term transmission of GPU. This finding also contributes to the debate on the spread of a physical conflict (Buhaug & Gleditsch, 2008; Hegre et al., 2010; Oneal & Russett, 1999), by supporting Virilio (1986) who viewed that territory has lost its significance, and that speed has become more critical in geopolitics than space.

To sum up, the spillover model of Barunik and Krehlik (2018) was employed to investigate further by splitting the overall transmission of GPR – computed through from Diebold and Yilmaz (2012) – into the short- and long-term components of GPU transmission. This exercise revealed that the basic features of GPU transmission, namely the geographical clustering and the pivotal role played by individual countries, continue to hold for both short- and long-term transmissions of GPU. However, the exercise also unveiled some additional features of GPU transmission, which are as follows: 1) the total and pairwise amounts of short-term GPU transmission is remarkably higher than that of its long-term counterpart but smaller than the overall GPU transmission computed earlier, meaning that the amount of GPU transmission becomes weaker from overall to short-term to long-term; 2) the role of bilateral and country-specific factors also become weaker with the reduction in the amount of GPU transmission; 3) while geographical proximity (border sharing and common distance) is an essential determinant of overall and short-term GPU transmissions, it does not seem to drive the long-term transmission of GPU. In this way, the investigation exercise not only confirms our primary findings on the GPU transmission but also deepens our understating of this phenomenon by considering the short- and long-term aspects of GPU transmission.

2.4 Concluding remarks

This essay quantifies GPU transmission across 19 countries. It explores whether bilateral and country-specific factors drive this transmission while using 19 news-based GPU indices of Caldara and Iacoviello (2018) for this purpose. After employing the spillover model of Diebold and Yilmaz (2012), a considerable amount of GPU transmission is found across the sample countries. A graphic description of these results depicts a geographical clustering among GPUs and highlights the countries that are the leading players in this transmission. A gravity model framework unveils that bilateral and country-specific factors explain the pairwise transmission of GPU. The results also hold for short- and long-term GPU transmissions, which are computed using Barunik and Krehlik (2018). Investors, managers, and governments may find it useful to incorporate these results in their decision-making processes.

Institutional investors and multinational corporations are often concerned with making assessments and predictions about GPUs that arise from the local and international arena. For them, the bilateral linkages and country-specific indicators suggested in this essay may be useful in predicting the course of GPU transmission between the two countries. These factors may also improve their assessments about a country’s susceptibility to or resilience against external GPU shocks. Furthermore, since international investments are usually spread across several geographical regions, the GPU's geographic clustering improves the understanding of the GPU concentrated regions as well as on the role of each country's GPU within those regions. In this way, this essay provides a broader picture to help to devise risk management strategies (perhaps by buying political violence and/or terrorism insurance) and to evaluate investment appraisals. Policymakers may also refer to this research when developing national security and counter-terrorism policies. The findings suggest that governments stay attentive, particularly to the geopolitical events occurring in their neighborhood and the ones involving their trading partners. That is because GPUs caused by those events may have adverse consequences for the national geopolitical landscape. Since shirking bilateral trade and exploiting geographical factors is not possible, improving fiscal imbalances, lowering debt burdens, and strengthening the domestic economy are few steps that may foster countries' resilience against external GPU shocks.

Although the essay tries to estimate GPU transmission, these estimations are primarily cross-sectional, static, and based on news information flows. Several questions remain and demand further investigations. For instance, future research may be aimed at investigating the dynamics of GPU transmission in terms of speed, volume, or time. In particular, researchers may examine the time-varying behavior of pairwise and total GPU transmissions. That could be achieved by applying the time-varying spillover models of Diebold and Yilmaz (2012) and Barunik and Krehlik (2018). Moreover, this research has strictly relied on the gravity model framework and the factors specific to this framework. There is, however, an exhaustive list of factors and approaches that might explain this phenomenon better.

This essay neither identifies a transmission medium such as the internet, phone calls, television, and radio that facilitate the transmission GPU, nor it points out any geopolitical conflicts whence a country's GPU emanates. The first question may be answered by extending the investigation of Weidmann (2015), which linked conflict spread to transnational phone calls. The second question may be answered by creating news-based indices that can capture the GPU of individual conflicts, and then by using those narrow indices along with the approach used in this essay.

Table 2-8 Appendix: details of data and sources

Variable name	Definition	Source
$Exports_{ij}$	Share of the total exports of origin country i to country j relative to the total exports of country i. It is averaged for the period between 1985 and 2016.	OECD STAN Bilateral Trade Database
$Imports_{ij}$	Share of the total imports of origin country i from country j relative to the total imports of country i. It is averaged for the period between 1985 and 2016.	OECD STAN Bilateral Trade Database
$Contiguous_{ij}$	A binary variable that takes 1 if origin country i and country j are sharing a border, and 0 otherwise.	CEPII
$Colony_{ij}$	A binary variable that takes 1 if origin country i has been a colony of country j, and 0 otherwise.	CEPII
Common $Colony_{ij}$	A binary variable that takes 1 if origin country i and country j have remained under the influence of same colonial power, and 0 otherwise.	CEPII
Common $Language_{ij}$	A binary variable that takes 1 if origin country i and country j share at least one common language, and 0 otherwise.	CEPII
$Distance_{ij}$	Physical distance (in kilometers) between origin country i and country j.	CEPII
Budget $Deficit_i$	Budget deficit (surplus) of country i as a percentage of its GDP. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
Budget $Deficit_j$	Budget deficit (surplus) of country j as a percentage of its GDP. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
$Debt_i$	Central government debt of country i as a percentage of its GDP. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
$Debt_j$	Central government debt of country j as a percentage of its GDP. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
$Area_i$	Geographical area (in squared kilometers) of country i. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
$Area_j$	Geographical area (in squared kilometers) of country j. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
Market $Capitalization_i$	Stock market capitalization of country i as a percentage of its GDP. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
Market $Capitalization_j$	Stock market capitalization of country j as a percentage of its GDP. The figure is averaged for the period between 1985 and 2016.	World Development Indicators (WDI)
$DS\__{ij}$	Directional mean spillover (in percent) of GPU transmitted by origin country i to country j.	These amounts are calculated by authors by applying the spillover model of Diebold and Yilmaz (2012) on 19 GPU series of Caldara and Iacoviello (2017). These series are available on http://www.policyuncertainty.com

3 CHAPTER 3 ESSAY TWO

Why do U.S. uncertainties drive stock market spillovers? International evidence

Studies in the extant literature have examined the impact of US uncertainty on international stock markets without paying much attention to the correlation between the US and the stock markets. This essay examines the role of US uncertainty in driving the US stock market's spillover to global stock markets, after controlling for the stock market correlation. To this end, a wide range of stock markets around the world, as well as three news-based uncertainties from the US (EPU, EMU, EMV) are considered. The empirical analysis reveals that the US uncertainties significantly cause the spillovers from the US to global stock markets. This causality from US uncertainties depends upon certain country-characteristics. Specifically, the US uncertainties explain better the spillovers between the US and target countries, when those target countries have a higher degree of financial openness, trade linkage with the US, and vulnerable fiscal position. Improved levels of stock market development in the target countries, however, mitigate their stock markets' vulnerability to the US uncertainty shocks. The essay offers potential insights and implications for investors and policymakers.

3.1 Introduction

International financial market integration has attracted a great deal of interest from researchers, professionals, and policymakers around the world (Barberis et al., 2005; Bekaert and Harvey, 1995 & 2005; Carrieri et al., 2007). The most intriguing question that surrounds this field is whether and why global stock markets undergo spillover (or contagion) effects, which are typically defined as a higher degree of correlation across financial asset returns or volatilities (Forbes & Rigobon, 2002). A wide range of empirical research emphasizes the presence of spillover effects across international stock markets (Hamao, Masulis, & Ng, 1990; Solnik et al., 1996; Longin & Solnik; 2001; and Bekaert & Harvey; 2003). Given the dominant role of the US market among world equity markets, many studies also focus on the spillover effects between the US and other stock markets (Ashanapalli & Doukas,1993; Rapach, Strauss, & Zhou, 2013; and Boubaker, Jouini, & Lahiani, 2016). While this empirical literature consistently documents the existence of spillover effects from the US to other stock markets, the debate continues to revolve around potential drivers of such spillover effects.

Several real-world events[19], along with an emerging strand of literature (Sum, 2012 & 2013; Colombo, 2013; and Dakhlaoui & Aloui, 2016) suggest that EPU in the US could be a possible driver of global stock market spillovers. This evidence so far is limited to stock markets of individual countries or regions only, including those of China (Li & Peng, 2017), Europe (Sum, 2012; Colombo, 2013), and BRIC[20] (Dakhlaoui & Aloui, 2016). Over the years,

[19] Tsai (2017) documents several examples of such events, such as China's stock market crash that occurred in June 2015. On June 12-July 9, 2015, the composite indices of two Chinese stock markets, namely the Shanghai Stock Exchange and the Shenzhen Stock Exchange, dropped by 35 percent and 40 percent, respectively. Just two months later, on August 24, 2015, a black swan event affected many stock markets around the world, and the stock indices of China, Japan, the United States, and European countries collapsed by huge amounts. As reported by the author, the financial press associated this event to the plans by the US Fed to raise interest rates, which lead to the panic among investors. This shows that uncertainty around US policies can be internationally contagious.
[20] BRIC stands for Brazil, Russia, India, and China.

however, stock markets around the world have become increasingly integrated with the US market, which, in turn, has increased the likelihood of US uncertainty flowing across borders – perhaps with higher speed and strength. It has thus become desirable to look at US uncertainties as a driving factor of stock market spillovers around the globe. To this end, this essay provides global evidence that spans well beyond regions or individual markets. It thus broadens the spectrum with which previous studies have not been able to address this issue. This global evidence exhibits a great deal of variation with regards to US uncertainties' spillover vulnerability for international stock markets, which asks for taking the following, more critical step: what are the determinants of stock market vulnerability to the US uncertainties?

Another issue that seems to prevail throughout the uncertainty-stock market literature is that, most often, this literature attempts to establish a direct connection between US EPU and the performance of global stock markets – where stock market performance is typically measured in terms of return or volatility of the stock markets (e.g., Chuliá et al., 2017, Ko & Lee, 2015, Lam & Zhang, 2014; Phan, Sharma, & Tran, 2018; and Su, Fang, & Yin, 2019). The underlying assumption is that a country's stock market performance is directly affected by external uncertainties, particularly when the uncertainty shocks originate from a major economy like the US. However, this assumption may not hold once one accounts for the fact that most international stock markets tend to co-move with the US market (Bekaert, Harvey, Lundblad, & Siegel, 2011). It follows then that international stock markets may well be more responsive to the changes from the US stock market than those from the US uncertainties. Accordingly, an alternative argument may be constructed that US uncertainties first lead to fluctuations in the US stock market, which then makes the other stock markets move. Hence, their performance appears to be affected by US uncertainties. Consequently, the US uncertainties may lead the co-movement (or spillovers) between the US and international stock markets, and, therefore, may serve as a driver for stock market spillovers. Accordingly, this essay examines the role of US uncertainty in driving the US stock markets spillover to global stock markets after controlling for the stock market correlation, which was largely ignored in the previous literature.

Given that stock markets worldwide are governed by investors who regularly revise their decisions based on new information, one can easily relate to how US uncertainties can lead to spillovers in international stock markets. Uncertainties around US policies and markets are likely to affect the behavior of all those institutional investors who participate in both the US and other international stock markets. This will likely enable US uncertainties to drive the movements between the US and international stock markets. Besides, empirical evidence suggests that individual investors tend to track and mimic the investment patterns of institutional investors (Kim & Ii, 2002), especially while reacting to the same news (Griffin, Harris, & Topaloglu, 2003). As a result, they may well consider revising their trading decisions, thus affecting the co-movements between the US and other stock markets. This seemed evident from the examples listed in footnote 17. In each example, major turbulences around the US economy and financial markets did not just end in the US but rather spread across other economies and international markets. This suggests that investors vigilantly observed the critical happenings around the US economy and financial markets. This phenomenon was also quite evident during the recent financial crisis of 2007-2008 when the stock market crash in the US rapidly spread to the international stock markets and consequently turned into a global financial crisis.

The studies cited above motivate us to investigate US uncertainties' driving effect for the stock market spillovers between the US and other countries, after controlling for the stock market correlation, and to further explore the determinants of stock market spillovers due to a given US uncertainty. The extant literature has shown a growing interest in the transmission of external uncertainty shocks on the local economy (Trung, 2019; Balli, Uddin, Mudassar, & Yoon, 2017; Jiang, Zhu, Tian, & Nie, 2019). This strand of the literature contends that certain country-specific macroeconomic/financial factors, such as trade and financial openness, fiscal imbalance, debt burden, and level of stock market development, determine the extent to which global shocks influence a domestic economy. Trade openness exacerbates a domestic economy's vulnerability to external shocks via dampening effects on exports, which constitute a large share of domestic output (Trung, 2019; Georgiadis, 2016; Giovanni & Levchenko, 2009; Kose et al., 2003; and Sakyi et al., 2015). Likewise, financial openness could also theoretically amplify the adverse effects of external shocks on the domestic economy (Mishkin, 2006), for instance, through its effects on capital flows (Aghion et al., 2004, Stiglitz, 2000). Excessive debt burdens and dwindling fiscal balances also worsen a country's economic sovereignty, thus making it more prone to foreign shocks. The extent of stock market development of a country, on the other hand, may serve as a deterrent against cross-border uncertainty shocks, and may, therefore, reduce the country's stock market's susceptibility to such shocks.

Interestingly, similar factors are relevant to global stock market integration (Ito & Chinn, 2006; Balli, Balli, Louis, & Vo, 2015; Chen & Zhang, 1997). As these macroeconomic/financial factors are commonly associated with both stock market integration and uncertainty shock transmission, one may argue that those factors may well explain the global stock market spillovers due to US uncertainties.

Against this backdrop, this essay begins by asking whether US uncertainties cause (or drive) spillovers between the US and global stock markets after controlling for the stock market correlation between the US and a given stock market? The answer to this question leads us to capture the extent of the causal effect for each stock market, which exhibits a considerable variation across global stock markets. As the final step, the variation around the casual effects is explained by the abovementioned country-specific macroeconomic/financial factors. Following these objectives, this essay considers a global sample of 38 stock markets, consisting of developed, emerging, and frontier markets, as well as three news-based uncertainty measures from the US, namely EPU, EMU, and EMV. The time-varying, stock market spillovers between the US and each stock market are computed using the dynamic conditional correlation (DCC-GARCH) model of Engle (2002). The linear Granger causality test is then applied to see whether US uncertainties cause the spillovers between the US and other stock markets. Then the generalized variance decomposition analysis within the VAR framework is applied to capture the extent of the causal effect. Finally, a cross-sectional regression is employed to explain the heterogeneity that exists within the sample countries for the extent of the casual effect.

The findings suggest that the US uncertainties significantly drive the spillovers from the US to global stock markets, after controlling for the well-known correlation. The highest magnitude of this causality is attributed to EMV, followed by EMU and EPU, respectively; while this magnitude varies significantly across our sample countries, and is explained by certain country-characteristics. More specifically, the US uncertainties explain better the spillovers between US and partner countries, when those partner countries have a higher degree of financial openness, trade linkage with the US, and vulnerable fiscal position. Improved levels of stock market development in partner countries, however, mitigate their stock markets' vulnerability to the US uncertainty shocks.

The present essay contributes threefold to the broader debate that connects foreign and local uncertainties to domestic stock markets (see, e.g., Boutchkova et al., 2012; Pastor & Veronesi, 2012 & 2013; and Smales, 2016). First, it provides global evidence on how US uncertainties drive spillovers between the US and other stock markets. It suggests that US uncertainties affect global stock markets after controlling for the time-varying correlation between the US and a given stock market. The effect of US uncertainties on international stock markets, while controlling for the stock market correlation, has been paid little attention so far (Li & Peng, 2017; Sum, 2012; Colombo, 2013; Dakhlaoui & Aloui, 2016). Besides, even though Klößner and Sekkel (2014) and Yin and Han (2014) provide relatively broader evidence on EPU spillovers between the US and other economies, those works are limited to EPU interactions only, while also studying the spillovers related to EMU and EMV.

The second contribution is towards the link between news-based measures of uncertainty and asset markets. While there are numerous studies relating news-based EPU to stock market returns and volatility (e.g., Hammoudeh & McAleer, 2015), and stock-bond market correlations (Li, Zhang, & Gao, 2015), such investigations are often conducted within a domestic context. Besides, even though EPU partly captures uncertainty surrounding the US stock market, other news-based measures of uncertainty have been recently developed in a bid to track US stock market uncertainty more precisely and are therefore gaining popularity. This essay considers two such newly developed measures, namely EMU and EMV, along with EPU, to provide international evidence on the power of US print for global stock markets.

Finally, and most importantly, the essay moves the US uncertainty-global stock market nexus literature (for instance, Phan et al., 2018) one-step further by indicating the potential factors that explain this nexus. Specifically, the essay provides evidence that country-specific macroeconomic/financial indicators, such as trade and financial openness, fiscal imbalance, and stock market development, determine the vulnerability of global stock markets to US uncertainty shocks. Trung (2019) documents similar country characteristics as the determinants of a given economy's vulnerability to US EPU shocks, yet the relevance of those characteristics for the stock market vulnerability remained unexplored. The present essay fills this gap.

The rest of the essay is organized as follows: Section 3.2 details methodology. Section 3.3 explains the dataset and results. Section 3.4 offers concluding remarks.

3.2 Methodology

3.2.1 Dynamic conditional correlations

The DCC-GARCH model of Engle (2002) is applied to capture the time-varying spillovers between the US and international stock markets. A significant advantage of using this model is the detection of possible changes in conditional correlations over time, which allows us to track dynamic investor behavior in response to news and innovations. Another advantage of this model is that it estimates correlation coefficients of the standardized residuals and so directly accounts for heteroscedasticity in the data (Chiang et al., 2007). Because this approach makes volatility-based adjustments, the volatility-induced biases in the time-varying correlations are minimized to a larger extent. Unlike the volatility-adjusted cross-market correlations used in Forbes and Rigobon (2002), the DCC-GARCH adjusts the correlation to the time-varying volatility continuously. Consequently, DCC offers a superior correlation indicator (Cho & Parhizgari, 2008).

The estimation of Engle's DCC-GARCH model comprises two steps: the first is the estimation of the univariate GARCH model, the second is the estimation of the conditional correlations that vary through time.

The multivariate DCC-GARCH model is defined as follows;

$$x_t = \mu_t + h_t^{1/2} \in_t \tag{1}$$

$$h_t = d_t r_t d_t \tag{2}$$

$$r_t = (diag(q_t))^{-1/2} q_t (diag(q_t))^{-1/2} \tag{3}$$

$$d_t = diag(\sqrt{l_{11,t}}, \sqrt{l_{22,t}}, \dots., \sqrt{l_{nn,t}}) \tag{4}$$

Where $x_t = (x_{1t}, x_{2t}, \dots, x_{nt})$ is a vector of past observations, h_t is the multivariate conditional variance, $\mu_t = (\mu_{1t}, \mu_{2t}, \dots, \mu_{nt})$ is the vector of conditional returns, $\in_t = (\in_{1t}, \in_{2t}, \dots, \in_{nt})$ is the vector of standardized residuals, r_t is an n×n symmetric dynamic correlations matrix and d_t is a diagonal matrix of conditional standard deviations for return series, obtained from estimating a univariate GARCH model with $\sqrt{l_{ii,t}}$ on the ith diagonal, $i = 1,2, \dots n$.

The DCC specification is defined as follows;

$$q_t = (1 - \varphi - \Im)\bar{q} + \Im q_{t-1} + \varphi \psi_{i,t-1} \psi_{j,t-1} \tag{5}$$

$$r_t = q_t^{*-1} q_t q_t^{*-1} \tag{6}$$

Where $q_t = [q_{ij,t}]$ is n×n time-varying matrix of standardized residuals ($\psi_{j,t} = \frac{\epsilon_{it}}{\sqrt{l_{i,t}}}$), $\bar{q}$ is the unconditional correlations of $\psi_{i,t}\psi_{j,t}$ and φ and $\Im$ are non-negative scalar parameters that satisfy $\varphi + \Im < 1$. $q_t^* = [q_{ii,t}^*] = \sqrt{q_{ii,t}}$ is the diagonal matrix with the square root of the i^{th} diagonal element q_t and its i^{th} diagonal position.

Therefore, for a pair of markets i and j their conditional correlation at time t can be defined as;

$$\rho_{ij,t} = \frac{(1-\varphi-\Im)\bar{q}_{ij}+\varphi\psi_{i,t-1}\psi_{j,t-1}+\Im q_{ij,t-1}}{\left[(1-\varphi-\Im)\bar{q}_{ii}+\varphi\psi_{i,t-1}^2+\Im q_{ii,t-1}\right]^{1/2}\left[(1-\varphi-\Im)\bar{q}_{jj}+\varphi\psi_{j,t-1}^2+\Im q_{jj,t-1}\right]^{1/2}} \tag{7}$$

Where q_{ij} is the element on the i^{th} line j^{th} column of the matrix q_t. The parameters are estimated using the quasi-maximum likelihood method (QMLE) introduced by Bollerslev et al. (1992). Under the Gaussian assumption, the log-likelihood of the estimators is given as;

$$L(\vartheta) = -\frac{1}{2}\sum_{t=1}^{T}\begin{bmatrix}(nlog(2\pi) + log|d_t|^2 + \epsilon_t' \, d_t^{-1} \, \epsilon_t) \\ +(log|r_t| + \psi_t' r_t^{-1}\psi_t + \psi_t'\psi_t)\end{bmatrix} \tag{8}$$

Where n is the number of equations, T is the number of observations, and ϑ is the vector of parameters to be estimated. The descriptive statistics and the stationarity-test results for the DCC series that are computed from the methodology explained in this section are provided in Tables 3-3 and 3-4, respectively.

3.2.2 The Granger causality test

After computing the DCC series, the next step is to investigate if there is a short-run (or lead-lag) causal relationship between a given US uncertainty and each of the DCC series. This section describes the Granger causality test for US EPU only; the same procedure is repeated for EMU and EMV. Since each of the DCC series is viewed as the time-varying spillover between the US and the market involved, the interest is to examine the lead-lag relationship between US EPU and the pairwise stock market spillovers. To test the lead-lag connections, I consider the following equations;

$$SPILL_t = \alpha_0 + \alpha_1 SPILL_{t-1} + \cdots + \alpha_i SPILL_{t-i} + \beta_1 USEPU_{t-1} + \cdots + \beta_i USEPU_{t-i} + \epsilon_t \quad (9)$$

$$USEPU_t = \alpha_0 + \alpha_1 USEPU_{t-1} + \cdots + \alpha_i USEPU_{t-i} + \beta_1 SPILL_{t-1} + \cdots + \beta_i SPILL_{t-i} + \epsilon_t \quad (10)$$

Where *SPILL* refers to the pairwise stock market spillover (DCC series) between the US and another stock market. That has been computed in the form of DCC from the above equation. US EPU refers to economic policy uncertainty in the US. The reported F-statistic is the Wald statistic for the joint hypothesis: $\beta_1 = \beta_2 = \beta_3 = \cdots = \beta_i = 0$

The null hypothesis is that EPU does not include Granger-cause *SPILL* in the first regression and that *SPILL* does not include Granger-cause EPU in the second regression. The selection of lags is based on Schwarz Information Criteria. The results of the first and second regression are reported in Tables 3-5 and 3-6, respectively. In passing, note that throughout the remainder of this essay, the spillover causality due to EPU, EMU, and EMV is called as EPU_causality, EMU_causality, and EMV_causality, respectively.

3.2.3 Generalized variance decompositions

Once the lead-lag relationship between US uncertainties and the pairwise stock market spillovers have been confirmed, the following step is to explore the extent of this relationship. Even though the Granger causality procedure informs us about a given US uncertainty's causal effect on the stock market spillovers between the US and a foreign stock market, it does not tell us anything about the extent (magnitude) of this causal effect. Unless the magnitude of this causality is estimated, one will not be able to determine the factors that could explain the causality, which is the prime objective of this essay. To this end, a VAR framework is employed to capture the generalized forecast error variance decompositions (GVDs) of the spillover-series (or DCC series). However, the results obtained from the traditional Cholesky decomposition approach are sensitive to the order of variables (Cheung & Yuen, 2002), and are often considered to be biased. Therefore, this essay uses GVDs to avoid such biases. In our case, GVDs measure the contribution of variation in a spillover-series (DCC) explained by its own and a given US uncertainty, therefore, detect the significance of innovations in each spillover series. As a supplement to the traditional Granger (in-sample) causality test, GVDs are considered out-of-sample causality analysis.

For each spillover series, I consider $y_t = (SPILL_t, EPU_t)$ which can be represented by the following VAR (p) model;

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \phi_i \, \Delta y_{t-1} + \varepsilon_t, \quad t = 1, \ldots.., \mathrm{T}, \tag{11}$$

Where α is the vector of constants, p is the lag lengths selected by AIC, T is the observation number. $\phi_1, \ldots, \phi_p$ are the coefficient matrices. ε_t is a vector of well-defined disturbances with covariance $E(\varepsilon_t \varepsilon_t') = \sum = (\sigma_{ij})_{2\times 2}$. When the jth element of ε_t is shocked by an amount of δ_j, then the responses of its own and other variables to this shock would be;

$$GI(n, \delta_j, \Omega_{t-1}) = E(y_{t+n}|\varepsilon_{jt} = \delta_j, \Omega_{t-1}) - E(y_{t+n}|\Omega_{t-1}) \tag{12}$$

where Ω_{t-1} denotes the non-decreasing information set up to $t-1$. If ε_t has a multivariate normal distribution, I have;

$$E(\varepsilon_t|\varepsilon_{jt} = \delta_j) = (\sigma_{1j}, \sigma_{2j})\sigma_{jj}^{-1}\delta_j = \sum e_j \sigma_{jj}^{-1}\delta_j \tag{13}$$

where e_j is the selection vector with unity as its j-th element and zero otherwise. By setting $\delta_j = \sqrt{\sigma_{jj}}$, the generalized impulse response of the effect of this one standard deviation shock in the j-th equation at time t on y_{t+n} is given by

$$\xi_j^g(n) = \frac{A_n \sum e_j}{\sqrt{\sigma_{jj}}}, n = 0,1,2,..., \tag{14}$$

where $A_n = \phi_1 A_{n-1} + \phi_2 A_{n-2} + \cdots + \phi_p A_{n-p}, n = 1,2,3, \ldots, A_0 = I, A_n = 0, for\ n < 0.$

These generalized responses can be used to calculate the forecast error variance decompositions, define as the proportion of the n-step ahead forecast error variance of i-th variable that is accounted for by the innovations in the j-th variable in the VAR system;

$$\theta_{ij}^{g}(n) = \frac{\sigma_{jj}^{-1}\sum_{l=0}^{n}(e_i^{`}A_l\sum e_j)^2}{\sum_{l=0}^{n}e_i^{`}A_l\sum A_l^{`}e_j} \ , n = 0,1,2, \ldots, \tag{15}$$

The results of the generalized variance decomposition, $\theta_{ij}^{g}(n)$, provide the optimal measure of the amount of variation in the i-th variable attributed by the innovations of j-th variable that would result from different possible orderings of the variables in VAR, thus according to Pesaran and Shin (1998) in general $\sum_{j=1}^{2}\theta_{ij}^{g}(n) \neq 1$. The variance decomposition results are presented in Table 3-7. Throughout the rest of this essay, the variance decompositions due to a given US uncertainty is called spillover vulnerably (SV). More specifically, the spillover vulnerability due to EPU, EMU, and EMV is named as $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$, respectively.

3.2.4 Cross-sectional determinants

As the reader will notice later in section 3.3.5, Table 3-7 exhibits considerable variability across countries for each of $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$. Given this variation in SV findings, one would wonder what makes the stock market spillovers in some countries more prone to a given US uncertainty than in others. As indicated by the literature (Trung, 2019; Georgiadis, 2016; Mishkin, 2006), the variation around SV magnitude could well be explained by some country-characteristics. Following this literature, a set of country-specific factors as explanatory variables are considered and used in the following cross-sectional regression, while the dependent variables are the SV estimates given in Table 3-7;

$$\mathrm{SV}_{\_EPU\_i} = \alpha_0 + \beta_1 FO_i + \beta_2 TO_i + \beta_3 DB_i + \beta_4 FI_i + \beta_5 MD_i + \epsilon_i \tag{16}$$

$$\mathrm{SV}_{\_EMU\_i} = \alpha_0 + \beta_1 FO_i + \beta_2 TO_i + \beta_3 DB_i + \beta_4 FI_i + \beta_5 MD_i + \epsilon_i \tag{17}$$

$$\mathrm{SV}_{\_EMV\_i} = \alpha_0 + \beta_1 FO_i + \beta_2 TO_i + \beta_3 DB_i + \beta_4 FI_i + \beta_5 MD_i + \epsilon_i \quad (18)$$

In Eq. (16)-(18), $\mathrm{SV}_{\_EPU\_i}$, $\mathrm{SV}_{\_EMU\_i}$, and $\mathrm{SV}_{\_EMV\_i}$ represent spillover vulnerability due to EPU, EMU, and EMV, respectively. TO_i denotes a country's trade openness with the US. FO_i, DB_i , FI_i, and MD_i indicate the measures for financial openness, debt burden, fiscal imbalance, and stock market development of a country, respectively. The results of the regression are presented in Table 3-8.

3.3 Dataset and results

3.3.1 Data

To assess the role of US uncertainties in driving the global stock market spillovers, I consider a broad range of stock markets. Monthly data on 38 equity markets from across the world are collected from the Thomson Reuter's Datastream over a period from January 1995 to December 2018[21]. The equity markets are chosen based on the MSCI classification of stock markets, given the availability of data. Over the same period, the data on three US uncertainties (EPU, EMU, and EMV) are download from the economic policy uncertainty website (https://www.policyuncertainty.com/). Data on country-specific variables, namely trade openness with the US, the central government's debt, budget deficit, and stock market capitalization, are gathered from the World Bank's World Development Indicators. In this essay, the financial openness index of Chinn and Ito (2008) is also used, which is downloaded

[21] We use MSCI classification of stock markets and select only those markets from each class for which US dollar indices are available on Datasteam. The appendix (Table 3-9) provided at the end contains the full list of stock markets included in our sample along with their classification.

from their website (http://Ib.pdx.edu/~ito/Chinn-Ito_Ibsite.htm). The appendix (Table 3-9) provided at the end lists the details of the data and their sources.

The data period covers a sufficiently long history during which many important events took place, and most of them had repercussions at both a regional and global scale. Such events include the 1997 South Asian financial crisis, the 2000 dot-com bubble in the US, the 2007 subprime mortgage crisis, the 2008 bankruptcy of Lehman Brothers, the 2010 European debt crisis, and the 2015 stock market crash in China.

The three different uncertainty indicators used in this essay are constructed from information contained in newspapers. The EPU index used in this essay is created by Baker et al. (2016) through an analysis of newspaper articles containing terms related to economic policy uncertainty. For this purpose, they select 10 large newspapers (USA Today, the Miami Herald, the Chicago Tribune, the Washington Post, the Los Angeles Times, the Boston Globe, the San Francisco Chronicle, the Dallas Morning News, the Houston Chronicle, and the WSJ). To construct the index, they perform monthly searches of each newspaper for terms related to economic and policy uncertainty. In particular, they search for articles containing the term 'uncertainty' or 'uncertain', the terms 'economic' or 'economy' and one or more of the following terms: 'congress', 'legislation', 'white house', 'regulation', 'federal reserve', or 'deficit'. The article counts are further scaled, standardized, and normalized with a mean of 100 to obtain the final index over a period from January 1985 to the present. Following the same method, the authors constructed the indices for EMU and EMV that also cover the same period. The differences and similarities between the three uncertainty indices can be noticed by looking at the term sets used to construct each index[22].

For the EMU index, the authors of Baker et al. (2016) consider a wide range of US newspaper and obtain daily counts of articles containing the term 'uncertainty' or 'uncertain', the terms 'economic' or 'economy' and one or more of the following terms: 'equity market', 'equity price', 'stock market', or 'stock price'. A monthly series of this daily series is used in this analysis.

Using the same approach, Baker, Bloom, Davis, and Kost (2019) have recently created a news-based EMV tracker that moves VIX and with the realized volatility of returns on the S&P 500. To do that, they select eleven major U.S. newspapers, namely the Boston Globe, Chicago Tribune, Dallas Morning News, Houston Chronicle, Los Angeles Times, Miami Herald, New York Times, San Francisco Chronicle, USA Today, Wall Street Journal, and Washington Post. To construct their overall EMV tracker, they specify terms in three sets as follows: the terms ‘economic’, ‘economy’, and ‘financial’ refer to the economy; the terms ‘stock market’, ‘equity’, ‘equities’, and ‘Standards & Poor’s’ (and their variants) refer to market; while the terms ‘volatility’, ‘volatile’, ‘uncertain’, ‘uncertainty’, ‘risk’, and ‘risky’ reflect volatility in the equity market.

3.3.2 Descriptive statistics

Tables 3-1 and 3-2 present the descriptive statistics for the stock market indices and the US uncertainties, respectively. Table 3-1 also indicates the MSCI classification of the stock

[22] Interested readers may refer to the economic policy uncertainty website (https://www.policyuncertainty.com/) for further details.

markets. Note that, in general, stock markets that yield higher mean returns are also (unsurprisingly) the ones with higher risk. Most of the return series are negatively skewed, and the significant value of Jarque-Berra (J.B.) statistics in most cases indicates the series are not normally distributed. Finally, the results of unit root tests, namely the Augmented Dickey-Fuller (Said and Dickey, 1984) and Phillips–Perron (Phillips & Perron, 1988), indicate that the stock price indices are not stationary. However, they become stationary when differenced, and thus their return series are used in our analysis.

On the other hand, the unit root test results given in Table 3-2 show that all three uncertainty-series are not only stationary at level but also when transformed into log-level form, suggesting that original uncertainty indexes can be used for conducting the empirical analysis. Also, notice that while EPU has the highest mean (116.24) value among three uncertainties, EMU exhibits the highest amount of standard deviation (59.47), which is understandable as uncertainty concerns about the stock market tend to fluctuate more than those about the whole economy. EMV, However, produces the lowest mean value and standard deviation. Non-normality of the three uncertainty-series is evident from the significance of J.B. statistics.

Table 3-1 Descriptive statistics of monthly stock market returns

Classification	Country	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J.B.
Developed	Australia	0.43	15.77	-31.89	5.93	-0.95	6.28	176.58***
	Austria	0.28	16.10	-42.32	6.38	-1.60	11.29	971.08***
	Belgium	0.42	14.51	-39.80	5.64	-1.70	11.89	1112.33***
	Canada	0.58	18.24	-31.14	5.57	-1.09	7.45	301.09***
	Denmark	0.75	17.00	-30.87	5.50	-1.12	7.60	322.43***
	Finland	0.52	25.93	-33.93	7.89	-0.45	5.05	61.63***
	France	0.47	13.61	-24.68	5.68	-0.72	4.43	50.74***
	Germany	0.36	17.42	-23.36	5.94	-0.78	4.80	69.42***
	Hong Kong	0.43	24.82	-34.66	6.84	-0.51	6.10	131.32***
	Ireland	0.39	17.62	-27.96	6.06	-1.17	6.49	216.23***
	Italy	0.19	19.24	-26.92	6.66	-0.39	3.79	15.08***
	Japan	0.01	14.36	-14.59	4.96	-0.07	3.15	0.50
	Netherland	0.36	14.68	-37.59	5.94	-1.58	9.79	690.64***
	New Zealand	0.43	14.60	-21.09	5.61	-0.69	4.20	40.92***
	Norway	0.44	17.02	-37.02	7.24	-1.28	8.03	392.27***
	Poland	0.33	31.79	-40.69	9.32	-0.46	5.30	75.57***
	Portugal	0.08	16.10	-33.35	6.22	-0.79	5.48	106.44***
	Singapore	0.22	23.23	-30.75	6.51	-0.51	6.14	134.43***
	South Korea	0.25	53.38	-38.87	10.01	0.21	6.92	190.94***
	Spain	0.40	17.42	-25.99	6.41	-0.56	4.38	38.84***
	Sweden	0.59	19.90	-30.81	6.81	-0.63	5.15	76.66***
	Switzerland	0.58	14.31	-17.05	4.55	-0.69	4.31	44.22***
	UK	0.27	13.35	-22.96	4.61	-0.72	5.48	101.40***
	USA	0.66	10.61	-19.11	4.35	-0.90	4.73	76.93***
Advanced Emerging	Brazil	0.36	32.85	-40.86	10.24	-0.65	5.05	72.56***
	Greece	-0.34	26.94	-41.37	9.94	-0.73	4.49	53.62***
	Malaysia	0.06	37.77	-35.92	7.61	-0.24	9.28	488.24***
	Mexico	0.47	19.31	-39.61	7.61	-1.31	7.62	347.36***
	South Africa	0.34	17.77	-43.83	7.88	-1.13	7.18	278.19***
	Taiwan	0.11	24.72	-25.39	7.38	-0.06	4.24	19.14***
	Thailand	0.08	33.98	-39.91	9.69	-0.50	6.12	131.98***
	Turkey	0.31	53.25	-52.78	13.69	-0.33	5.29	69.45***
Secondary Emerging	Chile	0.20	16.32	-27.73	6.07	-0.67	5.62	106.33***
	China	0.46	39.16	-31.16	9.54	0.05	4.68	35.00***
	Indonesia	0.16	44.39	-53.33	10.99	-0.71	7.28	249.79***
	Philippines	0.15	39.46	-31.86	7.48	-0.19	7.43	242.67***
Frontier	Argentina	-0.05	28.77	-37.09	10.14	-0.68	4.70	58.05***
	Venezuela	-0.58	100.29	-310.64	32.99	-4.69	41.11	18933.33***

Notes: The table provides a summary of the descriptive statistics for monthly returns (in percentage) of the equity market indices. The monthly average, maximum, minimum, standard deviation, skewness, kurtosis, and J.B. are denoted by Mean, Max., Min., Std. Dev., Skew., Kurt.,and Jerque-Berra test statistic, respectively. *, **, *** indicate significance at 10%, 5%, and 1% levels, respectively. The equity markets are chosen based on the MSCI classification of stock markets.

Table 3-2 Descriptive statistics of US uncertainties

	EPU	EMU	EMV
DF-GLS	-2.29**	-2.42**	-7.92***
PP	-8.32***	-8.26***	-9.01***
Mean	116.24	66.31	20.88
Med.	106.16	46.55	18.75
Max.	284.14	496.34	69.84
Min.	44.78	13.11	9.57
Std. Dev.	46.17	59.47	8.03
Skew.	1.11	2.94	2.31
Kurt.	4.12	15.1	11.03
J.B.	76.22***	2224.66***	1055.63***
Prob.	0.00	0.00	0.00
Obs.	288	288	288

Notes: The table provides a summary of the descriptive statistics for monthly series of three US uncertainties, namely economic policy uncertainty (EPU), equity market uncertainty (EMU), and equity market volatility (EMV). The monthly average, median, maximum, minimum, standard deviation, skewness, kurtosis, J.B., Prob., and Obs. are denoted by Mean, Med., Max., Min., Std. Dev., Skew., Kurt., Jarque-Berra test statistic, P-value, and number observations, respectively. Two stationarity test, DF-GLS test of Elliott, Rothenberg, and Stock (1996) and Phillips and Perron (1988)'s test, are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

3.3.3 Pairwise stock market spillovers

As mentioned earlier in the methodology section, the estimation of the pairwise stock market spillovers is performed between the US and every other stock market. These spillover-series are computed using the DCC model, which provides us 38 DCC series in total. Table 3-3 reports the descriptive statistics for the DCC series. Note that, in general, the dynamic conditional correlations between the US and other developed markets are higher than those for emerging and frontier markets, where the strongest (weakest) correlation is found for the UK (Venezuela). The strength of correlations tends to decrease as we move from developed to the frontier markets. In other words, the magnitude of spillovers becomes weaker with decreasing the level of market development. With few exceptions, a similar pattern is observed for variation (measured by standard deviation) of the DCC series. The non-normality and negative skewness of the series can also be witnessed from the table. Finally, Table 3-4 shows that DF-GLS and Phillips–Perron unit root tests are applied on the spillover series, which suggests that most of the spillover series are stationary, and therefore are suitable for the Granger causality test.

Table 3-3 Descriptive statistics of pairwise stock market spillovers (DCC series)

Region	Country	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J.B.	Obs.
Developed	Australia	0.67	0.89	0.39	0.12	-0.10	2.11	10.18**	288.00
	Austria	0.58	0.83	0.21	0.14	-0.13	2.32	6.52**	288.00
	Belgium	0.63	0.85	0.37	0.12	-0.20	2.20	9.99**	288.00
	Canada	0.76	0.86	0.55	0.06	-0.22	2.46	5.98*	288.00
	Denmark	0.65	0.81	0.38	0.09	-0.44	2.93	9.60**	288.00
	Finland	0.67	0.81	0.47	0.08	-0.16	2.55	3.84	288.00
	France	0.73	0.91	0.31	0.11	-0.87	3.75	44.13***	288.00
	Germany	0.74	0.90	0.02	0.13	-2.06	9.25	688.80***	288.00
	Hong Kong	0.64	0.80	0.37	0.05	-0.78	5.47	104.95***	288.00
	Ireland	0.68	0.90	0.21	0.12	-0.91	4.40	64.52***	288.00
	Italy	0.63	0.89	0.32	0.13	-0.04	2.54	2.72	288.00
	Japan	0.51	0.79	0.19	0.14	-0.01	2.35	5.18*	288.00
	Netherland	0.76	0.90	0.50	0.08	-0.31	2.55	7.34**	288.00
	New Zealand	0.56	0.74	0.25	0.11	-0.25	2.44	7.03**	288.00
	Norway	0.65	0.83	0.41	0.10	-0.22	2.34	7.87**	288.00
	Poland	0.55	0.82	0.08	0.13	-0.36	3.47	9.01**	288.00
	Portugal	0.53	0.77	0.28	0.10	0.00	2.66	1.43	288.00
	Singapore	0.61	0.75	0.50	0.07	0.70	2.32	29.66***	288.00
	South Korea	0.53	0.79	0.12	0.16	-0.45	2.50	13.13***	288.00
	Spain	0.66	0.82	0.45	0.07	-0.54	3.59	18.44***	288.00
	Sweden	0.74	0.89	0.43	0.09	-0.64	3.20	20.75***	288.00
	Switzerland	0.67	0.80	0.37	0.10	-0.76	2.85	28.69***	288.00
	UK	0.76	0.90	0.46	0.09	-0.77	3.31	30.59***	288.00
Advanced Emerging	Brazil	0.55	0.75	0.09	0.12	-0.91	4.49	67.83***	288.00
	Greece	0.52	0.86	0.07	0.14	-0.23	3.37	4.21	288.00
	Malaysia	0.45	0.60	0.31	0.06	0.42	2.59	10.71***	288.00
	Mexico	0.63	0.83	0.28	0.14	-0.88	2.68	39.70***	288.00
	South Africa	0.55	0.74	0.37	0.08	0.57	2.49	19.37***	288.00
	Taiwan	0.55	0.74	0.29	0.11	-0.29	2.11	13.96***	288.00
	Thailand	0.46	0.66	0.25	0.05	-0.09	5.72	91.22***	288.00
	Turkey	0.45	0.65	0.11	0.12	-0.82	3.20	33.87***	288.00
Secondary Emerging	Chile	0.51	0.62	0.37	0.05	-0.53	2.73	14.80***	288.00
	China	0.41	0.76	-0.01	0.18	-0.14	2.18	9.24***	288.00
	Indonesia	0.43	0.73	0.18	0.08	0.36	4.06	20.25***	288.00
	Philippines	0.43	0.51	0.32	0.04	-0.06	2.53	2.93	288.00
Frontier	Argentina	0.41	0.61	0.26	0.06	0.35	4.12	21.31***	288.00
	Venezuela	0.08	0.83	-0.66	0.17	0.20	7.40	240.13***	288.00

Notes: The table provides a summary of the descriptive statistics for dynamic conditional correlation (DCC series) between the US and a given stock market. The monthly average, maximum, minimum, standard deviation, skewness, kurtosis, J.B., and Obs. are denoted by Mean, Max., Min., Std. Dev., Skew., Kurt., Jerque-Berra test statistic, and number observations, respectively. *, **, *** indicate significance at 10%, 5%, and 1% levels, respectively. The equity markets are chosen based on the MSCI classification of stock markets.

Table 3-4 Unit root test for the pairwise stock market spillover series (DCC series)

Region	Country	DF-GLS	PP	
		Intercept	Intercept	Intercept and trend
Developed	Australia	-2.95***	-3.83***	-4.10***
	Austria	-2.02**	-1.92	-3.83***
	Belgium	-1.90*	-1.79	-3.64***
	Canada	-3.97***	-4.18***	-4.19***
	Denmark	-2.13**	-2.16	-3.47***
	Finland	-2.46**	-2.22	-3.20***
	France	-2.41**	-2.54	-3.91***
	Germany	-3.05***	-3.06***	-3.42***
	Hong Kong	-5.40***	-6.66***	-6.68***
	Ireland	-4.39***	-4.43***	-4.42***
	Italy	-2.59***	-2.66***	-4.92***
	Japan	-2.74***	-2.77***	-3.63***
	Netherland	-2.55**	-2.54	-3.14***
	New Zealand	-1.90*	-1.90	-3.26***
	Norway	-2.94***	-3.13***	-3.19***
	Poland	-2.69***	-3.07***	-3.34***
	Portugal	-2.66***	-2.83***	-3.62***
	Singapore	-2.35**	-2.24	-3.60***
	South Korea	-2.53**	-2.55	-3.94***
	Spain	-4.59***	-4.88***	-4.88***
	Sweden	-2.45**	-2.50	-3.21***
	Switzerland	-1.62	-1.61	-3.60***
	UK	-2.42**	-2.68***	-4.82***
Advanced Emerging	Brazil	-1.09	-0.81	-0.57
	Greece	-3.19***	-3.25***	-3.49***
	Malaysia	-2.23**	-2.12	-4.76***
	Mexico	-2.20**	-2.28	-4.25***
	South Africa	-1.95**	-2.43	-3.46***
	Taiwan	-1.56	-1.75	-3.74***
	Thailand	-4.97***	-5.43***	-5.52***
	Turkey	-1.29	-1.15	-3.90***
Secondary Emerging	Chile	-2.50**	-2.67***	-3.67***
	China	-2.15**	-2.09	-3.59***
	Indonesia	-5.77***	-6.52***	-6.51***
	Philippines	-2.31**	-2.36	-4.66***
Frontier	Argentina	-2.98***	-2.98***	-3.38***
	Venezuela	-0.96	-15.04***	-15.02***

Notes: The table provides a summary of the unit root tests applied to test the stationarity of dynamic conditional correlation (DCC series) between the US and a given stock market. Two unit-root tests, the DF-GLS test of Elliott, Rothenberg, and Stock (1996) and Phillips and Perron (1988)'s test, are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

3.3.4 Results of the Granger causality test

Once the diagnostic checking of the spillover and the three US uncertainty series is confirmed, the next step is to test whether the US uncertainties lead the spillovers between the US and other stock markets, or the vice versa is true. The results of the Granger causality test are reported in Tables 3-5 and 3-6. Table 3-5 includes the results of the causality from the three US uncertainties to stock market spillovers (Eq.(10)), while Table 3-6 shows the results of causality in the opposite direction (Eq.(11)). It is evident from Table 3-5 that the three US uncertainties strongly lead the stock market spillovers. That is, EPU_causality, EMU_causality, and EMV_causality are all found to be highly significant. The causal effect is not only consistent for three uncertainty indicators but across countries and classification. Put differently, the news-based uncertainties in the US lead international stock market spillovers, regardless of the uncertainty type. While F-statistics does not say anything about the strength of causality, it should be noted that as we move from EPU to EMV, the F-statistic increases in scale. It could mean that EMV is much more influential in generating spillovers on the stock market and is preceded by EMU and EPU, respectively. Nonetheless, this conclusion should be drawn carefully and backed by a test (carried out later) that could capture the degree of causality.

Table 3-5 Results of Granger-causality test

Cause=>		EPU		EMU		EMV	
Class	Country	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
Developed	Australia	14.71***	0.00	15.21***	0.00	30.08***	0.00
	Austria	5.24**	0.02	10.60***	0.00	23.97***	0.00
	Belgium	4.94**	0.03	16.93***	0.00	19.11***	0.00
	Canada	15.22***	0.00	15.64***	0.00	31.61***	0.00
	Denmark	8.58***	0.00	13.77***	0.00	18.54***	0.00
	Finland	2.36	0.12	1.88	0.17	6.81**	0.01
	France	3.70*	0.05	12.87***	0.00	16.41***	0.00
	Germany	7.39**	0.01	22.60***	0.00	21.32***	0.00
	Hong Kong	9.95***	0.00	7.93**	0.01	14.05***	0.00
	Ireland	6.03**	0.01	10.88***	0.00	16.69***	0.00
	Italy	5.75**	0.02	13.22***	0.00	19.40***	0.00
	Japan	9.47***	0.00	14.14***	0.00	31.08***	0.00
	Netherland	5.18**	0.02	7.92**	0.01	8.21***	0.00
	New Zealand	9.28***	0.00	11.35***	0.00	21.56***	0.00
	Norway	21.60***	0.00	24.39***	0.00	24.54***	0.00
	Poland	4.36**	0.04	8.57***	0.00	21.68***	0.00
	Portugal	9.96***	0.00	13.84***	0.00	23.64***	0.00
	Singapore	14.36***	0.00	13.40***	0.00	27.62***	0.00
	South Korea	7.42**	0.01	15.27***	0.00	22.95***	0.00
	Spain	10.70***	0.00	26.36***	0.00	36.35***	0.00
	Sweden	10.13***	0.00	13.37***	0.00	10.57***	0.00
	Switzerland	7.43**	0.01	16.06***	0.00	20.43***	0.00
	UK	9.00***	0.00	15.72***	0.00	25.62***	0.00
Advanced Emerging	Brazil	10.60***	0.00	9.76***	0.00	15.87***	0.00
	Greece	14.31***	0.00	26.24***	0.00	31.58***	0.00
	Malaysia	2.58	0.11	8.21***	0.00	14.05***	0.00
	Mexico	0.39	0.53	8.05***	0.00	17.40***	0.00
	South Africa	3.64*	0.06	10.25***	0.00	21.60***	0.00
	Taiwan	9.51***	0.00	14.98***	0.00	20.56***	0.00
	Thailand	16.23***	0.00	15.06***	0.00	20.54***	0.00
	Turkey	10.16***	0.00	17.22***	0.00	17.75***	0.00
Secondary Emerging	Chile	12.52***	0.00	19.61***	0.00	28.01***	0.00
	China	11.24***	0.00	6.44**	0.01	17.54***	0.00
	Indonesia	5.18**	0.02	4.25**	0.04	21.23***	0.00
	Philippines	5.15**	0.02	6.37***	0.01	19.17***	0.00
Frontier	Argentina	11.86***	0.00	11.01***	0.00	22.55***	0.00
	Venezuela	0.31	0.58	0.29	0.59	0.02	0.90

Notes: The table provides the results of the Granger-causality test run between a given US uncertainty and the pairwise spillovers between the and a given stock market. Specifically, this table includes the results of Eq. (9). The reported F-statistics are the Wald statistics for the following null hypothesis: a given US uncertainty does not granger cause pairwise stock market spillover. The selection of appropriate lags is mad through Schwartz Information Criteria. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 3-6 Results of Granger-causality test

Caused=>		EPU		EMU		EMV	
Class	Country	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
Developed	Australia	3.93	0.05	0.00	0.97	0.04	0.85
	Austria	0.29	0.59	4.08**	0.04	0.10	0.76
	Belgium	0.44	0.51	5.58**	0.02	2.01	0.16
	Canada	8.19***	0.00	1.08	0.30	0.47	0.49
	Denmark	0.92	0.34	0.02	0.89	0.43	0.51
	Finland	0.71	0.40	0.81	0.37	0.21	0.65
	France	0.81	0.37	0.00	0.97	0.32	0.57
	Germany	0.07	0.79	0.10	0.75	1.12	0.29
	Hong Kong	3.18*	0.08	0.91	0.34	0.06	0.81
	Ireland	2.71	0.10	0.20	0.65	1.27	0.26
	Italy	0.92	0.34	0.06	0.81	0.01	0.92
	Japan	8.87***	0.00	0.85	0.36	0.43	0.51
	Netherland	0.06	0.80	2.11	0.15	4.36**	0.04
	New Zealand	2.06	0.15	0.15	0.69	0.28	0.60
	Norway	1.18	0.28	0.37	0.54	1.76	0.19
	Poland	0.04	0.83	1.72	0.19	0.87	0.35
	Portugal	2.69	0.10	0.08	0.78	0.00	0.98
	Singapore	1.32	0.25	0.25	0.62	0.21	0.65
	South Korea	2.68	0.10	0.90	0.34	0.18	0.67
	Spain	0.58	0.45	0.02	0.88	0.58	0.44
	Sweden	0.00	0.99	0.98	0.32	2.95*	0.09
	Switzerland	1.01	0.32	6.59**	0.01	8.26***	0.00
	UK	5.71**	0.02	1.85	0.17	0.01	0.93
Advanced Emerging	Brazil	0.05	0.81	0.00	0.95	1.09	0.30
	Greece	0.25	0.62	1.67	0.20	0.78	0.38
	Malaysia	0.00	0.97	4.10**	0.04	3.16*	0.08
	Mexico	1.00	0.32	0.65	0.42	0.23	0.63
	South Africa	0.98	0.32	0.79	0.37	0.14	0.71
	Taiwan	0.00	1.00	0.63	0.43	2.22	0.14
	Thailand	2.05	0.15	0.27	0.60	0.02	0.88
	Turkey	0.29	0.59	0.23	0.63	1.09	0.30
Secondary Emerging	Chile	0.09	0.77	0.22	0.64	1.01	0.32
	China	0.31	0.58	5.67**	0.02	1.59	0.21
	Indonesia	0.44	0.51	2.26	0.13	0.58	0.45
	Philippines	3.43*	0.06	0.01	0.91	0.04	0.85
Frontier	Argentina	0.29	0.59	2.83**	0.09	0.30	0.58
	Venezuela	0.67	0.41	1.21	0.27	0.90	0.34

Notes: The table provides the results of the Granger-causality test run between a given US uncertainty and the pairwise spillovers between the and a given stock market. Specifically, this table includes the results of Eq. (10). The reported F-statistics are Wald statistics for the following null hypothesis: a given pairwise stock market spillover does not granger cause US uncertainty. The selection of appropriate lags is mad through Schwartz Information Criteria. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Turning to the findings shown in Table 3-6, note that in the reverse direction, i.e., from stock market spillovers to US uncertainties, hardly any causality was found, which is consistent with the literature (Tsai, 2017; Liow, Liao, & Huang, 2018) as well as common understanding. Finally, it is reiterated that our causality results are based on F-statistic, which informs us about whether there is causality or not. More precisely, while it captures the existence of causality from the US uncertainties to the stock market spillovers, it tells nothing about the extent of this causality. The ultimate objective of this essay is not just to point out the existence of causality, but it is to uncover what determines this causality. For this purpose, there needs to be a measure that can provide the extent of the causality and can further help explore its determinants.

3.3.5 Results of variance decompositions

As outlined in the methodology section, the generalized forecast variance decompositions (GVD), named as SV, are used within the VAR system to capture the magnitude of causality from the EPU, EMU, and EMV to the international stock market spillovers. Accordingly, $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$ represent the contribution of EPU, EMU, and EMV to the spillover variation in international stock markets, respectively. Table 3-7 shows the results[23] for $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$. The results support the previous findings that were obtained through the granger causality test. The results provided in columns (1)-(3) indicate that followed $SV_{\_EMU}$ and $SV_{\_EPU}$; the magnitude of $SV_{\_EMV}$ is the largest for the global stock markets.

[23] We compute the GVDs for 3,6, and 12 month forecast horizons, but obtain similar results. To achieve brevity, we report the results with 12 month forecast horizon only. Results with other forecast horizons may be provided on request.

Table 3-7 Generalized variance decompositions (SV) of the pairwise stock market spillovers (DCC series)

Region	Country	$SV_{\_EPU}$ (1)	$SV_{\_EMU}$ (2)	$SV_{\_EMV}$ (3)
Developed	Australia	9.43	10.77	21.02
	Austria	1.85	5.85	21.89
	Belgium	2.73	11.54	19.91
	Canada	12.11	13.39	21.73
	Denmark	6.12	13.67	18.24
	Finland	2.17	4.72	11.07
	France	2.31	12.74	18.36
	Germany	3.93	17.58	18.33
	Hong Kong	6.85	6.16	9.52
	Ireland	6.13	10.26	18.19
	Italy	2.92	10.64	17.34
	Japan	6.82	11.25	23.24
	Netherland	4.81	10.76	11.03
	New Zealand	4.44	6.85	18.68
	Norway	12.26	18.64	19.65
	Poland	2.84	8.81	19.97
	Portugal	6.42	11.41	17.73
	Singapore	7.58	6.48	16.58
	South Korea	3.60	6.88	13.06
	Spain	4.97	16.10	24.31
	Sweden	7.96	15.03	11.24
	Switzerland	4.30	13.34	18.77
	UK	5.96	12.84	22.11
Advanced Emerging	Brazil	5.20	12.30	17.11
	Greece	5.70	12.42	21.83
	Malaysia	0.90	3.94	11.82
	Mexico	0.14	6.32	18.35
	South Africa	1.91	7.52	17.94
	Taiwan	5.16	8.91	16.44
	Thailand	6.46	6.59	12.30
	Turkey	6.21	13.98	16.80
Secondary Emerging	Chile	4.44	15.03	22.88
	China	7.05	3.09	13.42
	Indonesia	3.03	1.52	13.15
	Philippines	3.84	5.71	15.92
Frontier	Argentina	5.54	8.25	15.28
	Venezuela	0.49	1.28	0.12

Notes: The table shows the share of generalized variance decompositions (GVDs) of the pairwise spillovers (DCC series) that are due to the shocks to a given US uncertainty. Obtained from the VAR model, the reported magnitudes of the GVDs are computed at a 12-month forecast horizon. The selection of appropriate lags is mad through Schwartz Information Criteria. I also compute GVDs at a shorter forecast horizon but end up obtaining similar results. Although not reported due to space consideration, those results may be obtained on request. SV refers to spillover vulnerability, while $SV_{\_EPU,}$ $SV_{\_EMU}$, and $SV_{\_EMV}$ refer to spillover vulnerability due to EPU, EMU, EMV, respectively.

More specifically, the extent of SV due to EMV, given in column (3) is generally higher than that in column (2), indicating the SV due to EMU is the second largest, while that due to EPU is relatively the smallest for the stock markets around the world. However, regardless of the uncertainty type, the SV results show substantial variation across our sample countries. In general, after controlling for the stock market correlation, stock market spillovers for some countries appear to be more vulnerable to the US uncertainties than others. Motivated by the variation in SV results, I undertake the further exploration of country characteristics that can explain this variation.

3.3.6 Cross-sectional regression results

A cross-sectional regression is employed to explore the determinants of SV from US uncertainties ($SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$). Inspired by the current literature on the global effects of EPU, a set of country-specific factors as explanatory variables are considered in the regression, while the dependent variable being the estimates of $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$ given in Table 3-7. The country-specific explanatory variables include a country's trade openness with the US (TO_i), financial openness (FO_i), debt burden (DB_i), fiscal imbalance (FI_i), and level of stock market development (MD_i). The results of our cross-sectional regression are provided in Table 3-8, where Newy-West HAC is applied to obtain robust standard errors that account for heteroscedasticity and autocorrelation in data.

The second, third, and fourth columns of Table 3-8 display the coefficients of explanatory variables when the dependent variables, $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$, that correspond to the columns (1)-(3) of Table 3-7, respectively.

Table 3-8 Determinants of spillover vulnerability (SV) of the pairwise stock market spillovers

	$SV_{\_EPU}$ (1)	$SV_{\_EMU}$ (2)	$SV_{\_EMV}$ (3)
Intercept	3.60**	7.12***	11.58***
	(1.47)	(1.93)	(2.60)
$FO_{\_i}$	1.11**	1.77**	2.34***
	(0.40)	(0.64)	(0.78)
$TO_{\_i}$	1.59**	2.44*	4.34***
	(0.68)	(1.23)	(1.43)
$DB_{\_i}$	0.00	-0.02	0.00
	(0.01)	(0.02)	(0.03)
$FI_{\_i}$	0.14**	-0.11	-0.07
	(0.05)	(0.09)	(0.12)
$MD_{\_i}$	-0.01*	-0.02**	-0.03***
	(0.00)	(0.01)	(0.01)
R-squared	24%	27%	46%
No. of observations	37	37	37

Notes: The table reports the results of cross-sectional regression, given in Eq. (16), with HAC robust standard errors in parenthesis. $SV_{\_EPU}$, $SV_{\_EMU}$, and $SV_{\_EMV}$ indicate dependent variables in Eq. (16) repressing spillover vulnerability (SV) due to EPU, EMU, and EMV, respectively. $FO_{\_i}$, $TO_{\_i}$, $DB_{\_i}$, $FI_{\_i}$, $MD_{\_i,}$ respectively denote explanatory variables, namely financial openness, trade openness with the US, debt burden, fiscal imbalance, and stock market development. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

In Table 3-8, column (1) shows that the coefficient of financial openness (FO_i) is 1.11, which is significant at 5 percent. It implies that a unit increase in financial openness, as measured by the financial openness index of Chinn and Ito (2008), increases $SV_{\_EPU}$ by 1.11 percent. In other words, the susceptibility of a country's stock market to US EPU is significantly driven by the degree of financial openness in that country. Similarly, at 5 percent significance, a percentage increase in a country's trade openness with the US (TO_i) increases $SV_{\_EPU}$ by 1.59 percent. This result indicates that the more a country trades with the US, the more US EPU-sensitive its stock market becomes. Likewise, the rising fiscal imbalance of a country also makes the stock market spillovers of that country more responsive to US EPU. More precisely, with a 5 percent significance, a percentage[24] rise in fiscal imbalance (FI_i) of a country increases $SV_{\_EPU}$ by 0.14 percent.

[24] Remember it's a percentage of GDP.

On the other hand, the level of stock market development, as measured by stock market capitalization as a percentage of GDP, seems to hinder or mitigate $SV_{\_EPU}$. Note the coefficient of market development (MD_i) is -0.01, which is negative and significant at the 10 percent level. It suggests that a percentage increase in the level of a country's stock market development leads to a 0.01 percent decrease in $SV_{\_EPU}$. In other words, improving development levels of stock markets in our sample countries tend to hinder the EPU shocks coming from the US to their stock markets.

The results for EMU and EMV are presented respectively in columns (2) and (3) of Table 3-8. Notice that, while fiscal imbalance loses its significance in both the columns, the results for the previously significant variables – financial openness, trade openness with the US, and stock market development – continue to hold. Interestingly, the coefficient for EMU, in column (2), is stronger than before and becomes strongest for EMV.

Overall, the results obtained through the cross-sectional regression suggest that the vulnerability of an international stock market from the US uncertainties depends upon certain country-characteristics. Higher degrees of financial openness, trade openness with the US, and fiscal imbalance makes the country's stock markets more vulnerable to US uncertainties. Countries with improving levels of stock market development, on the other hand, are better prepared to mitigate their stock market's vulnerability to US uncertainties.

3.4 Concluding remarks

This essay examined the role of US uncertainties in driving the spillovers between the US and international stock markets. A wide variety of stock markets around the world and three news-based uncertainties from the US were considered for this purpose. First, the DCC-

GARCH model was employed to compute the time-varying spillovers between the US and each stock market in our sample, which was followed by a linear Granger causality test to see whether US uncertainties cause these pairwise spillovers. The magnitude of this causality was ascertained through the generalized variance decomposition analysis within the VAR framework. Substantial heterogeneity was found among our variance decomposition results, which was explained by certain country-characteristics. I found that a higher degree of financial openness, trade openness with the US, and fiscal imbalance of a country exacerbate its stock market's vulnerability to US uncertainties, while the more developed stock markets seem to mitigate their exposure to the uncertainty shocks.

The essay offers important implications for investors and policymakers. First, several studies support the view that countries with a higher degree of trade openness are generally more likely to grow faster. However, a country's trade openness with a specific trading partner could make the country's economy, and thus its financial markets, more integrated with that of the trading partner. Trade openness with a given trading partner could, therefore, have implications for the stock of a country. In this regard, our results suggest that despite academic evidence of its potential gains to the economy as a whole, trade openness with a specific country, and particularly that with a large economy such as the US, could well amplify the stock market spillovers that are due to economic and financial uncertainty of the partner country. That would further mean that when it comes to trade openness, countries should strive for trade diversification as much as to avoid their bilateral trade of becoming too concentrated on a few trading partners. In this way, trade diversification may allow countries to preserve the benefits of trade openness while, at the same time, minimizing their stock markets' exposure from external shocks of uncertainty.

Our findings also suggest a similar amplification role played by higher levels of financial openness and fiscal imbalances (only significant in the case of $SV_{\_EPU}$) in the countries. Increased financial openness is related to more effective financial regulations and more transparent financial markets. Capital markets with such attractive features draw a large amount of capital flows from around the world. Empirical evidence shows that uncertainty is a source of volatility in global capital flows and that capital flows can act as a channel through which uncertainties may cause global stock market spillovers. Investors and policymakers should, therefore, take into account the degree of financial openness in a country's financial system, as well as the capital flows coming from the US to that country; since these two factors could well combine to potentially amplify the uncertainty-generated stock market spillovers from the US to the stock markets of such a country.

Similarly, weaker fiscal imbalances reflect poor economic governance, which is more likely to translate into uncertainty around macro-economic policies. Consequently, stock markets of the countries with more uncertain macro-economic conditions are more vulnerable to uncertainty-generated stock market spillovers from the US. Investors and policymakers should, therefore, consider the exacerbating character of a host country's fiscal imbalances for stock market spillovers that are due to uncertainty-related shocks in the US equity market, and thus take appropriate actions to mitigate this impact.

Finally, our finding that developed stock markets appear to be resilient against uncertainty-driven spillovers is quite intuitive. Developed stock markets typically have measures in place with regards to investor protection and capital controls, making them more immune to external uncertainty shocks. This finding further implies that while investors should consider investing in developed stock markets, policymakers should continue to take steps towards stock market development.

Overall, this essay asks international investors and policymakers to pay close attention to the fact that after controlling for the correlation between the US and a given country's stock market, the driving effect of US uncertainties for the stock market is linked to specific features of the host country such as the trade openness with the US, financial openness, fiscal imbalance, and the degree of stock market development.

Table 3-9 Appendix: List of the countries, variables, and data sources

Countries					
Developed			Advanced emerging	Secondary emerging	Frontier
Australia	Hong Kong	Portugal	Brazil	Chile	Argentina
Austria	Ireland	Singapore	Greece	China	Venezuela
Belgium	Italy	South Korea	Malaysia	Indonesia	
Canada	Japan	Spain	Mexico	Philippines	
Denmark	Netherland	SIden	South Africa		
Finland	New Zealand	Switzerland	Taiwan		
France	Norway	United Kingdom	Thailand		
Germany	Poland		Turkey		

Variables		
Indicator	Measurement	Source
Financial openness (FO)	Financial openness index of a country constructed by Chinn and Ito (2008). It is the average for the period between 1995-2018	http://Ib.pdx.edu/~ito/Chinn-Ito_Ibsite.htm
Trade openness (TO)	Exports plus imports with the US relative to the total trade of a country. It is the average for the period between 1995-2018	World Development Indicators(WDI), World Bank
Debt burden (DB)	Central government debt of a country as a percentage of GDP. It is the average for the period between 1995-2018	WDI
Fiscal imbalance (FI)	Budget deficit (surplus) of a country as a percentage of GDP. It is the average for the period between 1995-2018	WDI
Market development (MD)	Stock market capitalization of a country as a percentage of GDP. It is the average for the period between 1995-2018	WDI

4 CHAPTER 4 ESSAY THREE

Economic Policy Uncertainty Spillover Effects on Sectoral Equity Returns: Evidence from New Zealand

This essay introduces a weekly EPU index for New Zealand, and examines the return and volatility spillovers from New Zealand (local) and US (foreign) EPU on NZSE and sectoral indices of New Zealand stock market. The multivariate VAR (1)-BEKK-GARCH model is employed for this purpose. Overall, the findings suggest that NZ equity sectors and NZSE receive much stronger and more pronounced spillover effects from US EPU compared to the local counterpart (NZ EPU). While the return spillovers from both EPUs are somewhat similar yet limited to just a few sectors, the volatility spillovers from US EPU on NZ sectors outstrip those from the NZ EPU. For volatility spillovers, the domestically oriented sectors are mainly vulnerable to NZ EPU, while those having export/import concentration with the US are mainly susceptible to US EPU. These findings may be useful to investors seeking sectoral diversification opportunities across New Zealand and the US.

4.1 Introduction

Studies – primarily performed within the US context – show that US EPU tends to increase (decrease) volatility (returns) of US stock market (Pástor & Veronesi, 2012 & 2013; Antonakakis, Chatziantoniou, & Filis, 2013; Brogaard & Detzel, 2015; Bijsterbosch & Guerin, 2013; Liu & Zhang, 2015). Apart from these domestic effects, US EPU carries a significant potential to cause return and volatility spillovers on global stock markets, such as those of BRIC (Dakhlaoui & Aloui, 2016), while being the source of movements in several international stock markets (Ko & Lee, 2015). Studies further argue that EPU spillovers for international stock markets may even be stronger if the EPU shocks are emanating from a large economy (Sum, 2013), such as the US, and more so if the target country happens to be a small open economy (Stockammar & Österholm, 2016). Accordingly, a domestic stock market could experience more EPU shocks from the foreign landscape than from the local arena; this may be especially true for a small open economy that has stable monetary policy regimes, smaller size, and a higher degree of trade and capital openness. The literature also indicates that both the local and foreign EPUs are likely to shed negative (generally positive) spillover effects on the local stock market's returns (volatility).

While the empirical literature cited above confirms the existence of EPU spillovers for stock markets around the world, some questions still need further investigation. First, the presence of EPU spillovers has been investigated rigorously for many international stock markets. Nevertheless, most of the analyses have been carried out at an aggregate level of the stock market, disregarding the possibility that various sectors of the stock market may respond heterogeneously to the prevailing uncertainties. It is worth noting that market aggregation may mask the critical features of different equity sectors. The aggregate stock market index is the traditional proxy for the benchmark market portfolio, which only represents average investors who are concerned with its riskiness and therefore is of little use to the investors who want to benefit from sectoral diversification at domestic or international level. It is expected that due to the unique sector dynamics, each sector may be exposed to uncertainty arising from the domestic and international landscapes differently. It is well-known that, unlike the market portfolio, some sectors are cyclical while others are countercyclical, some deal in necessities while others in luxuries, some are more import-oriented (or export-oriented) than others while some other sectors are connected tightly to the global financial hubs and are therefore highly prone to foreign policy shocks. In other words, the equity market sectors could be extremely heterogeneous in their exposure to local (foreign) EPUs. Despite being possible, the literature in this direction is scant. The only exceptions are Yu, Fang, Zhang, and Du (2018) and Yu, Fang, Du, and Yan (2017), who investigated the effects of US EPU on the volatility and long-run beta of different sectors of US stock market.

Second, the previous studies have mainly examined EPU spillovers from the US to the stock markets of either BRIC countries or Europe's large economies (e.g., Dakhlaoui & Aloui, 2016), and thus have paid little attention to small-open economies. Third, when examining the EPU spillovers for a local stock market, the current literature places an overwhelming emphasis on the EPU shocks originating from the US yet ignores those arising from the local policy uncertainty. Fourth, with regards to the direction of EPU spillovers, the theoretical expectation is that return (volatility) spillover should be negative (positive) (Pastor & Veronesi, 2012), whether the source being local and foreign. In the empirical literature, however, the negative sign of return (mean) spillover is consistently reported; the positive sign of volatility spillover, on the other hand, is not found consistent across countries. Despite being counterintuitive, the volatility spillovers on BRIC stock markets from the US EPU, for instance, are found to oscillate between positive and negative values (Dakhlaoui & Aloui, 2016), meaning that nothing can be said with absolute certainty about the direction of volatility spillovers. After all, EPU shocks in the US could well be received as good news in certain markets (Su, Fang, & Yin, 2019), and, in turn, the volatility of such markets could decrease while responding to higher US EPU. One may, therefore, be interested in revisiting the EPU spillovers for markets where the general theoretical expectation of EPU-volatility relationship may vary.

This essay investigates the return and volatility spillovers from local (NZ) and foreign (US) EPU on NZSE and sectoral indices of the New Zealand stock market. Our choice to use US EPU as a surrogate for foreign EPU is based on current literature (Colombo, 2013; Klößner & Sekkel, 2014; Dakhlaoui & Aloui, 2016; Ko & Lee, 2015). This literature consistently argues that the US is, although to varying degrees, the source, and not the target, of uncertainty (volatility) in global economies (stock markets). In the context of small open economies, two related works, one on New Zealand and another on small-open economies, provide enough support to our choice. With an emphasis on New Zealand, Kamber, Karagedikli, Ryan, and Vehbi (2016) found asset prices dropping in the country in response to US uncertainty[25]. The study found financial and confidence linkages between New Zealand and the US as more critical conduits for shock transmission relative to the trade channels. The other study, Stockammar and Österholm (2016), concluded that US uncertainty significantly reduces GDP growth in five small open economies[26] and affects the volatility of their stock markets. These two studies are much broader in scope and do not just examine EPU spillover on stock markets, they, nonetheless, set a potential course for such spillover effects from US EPU to the New Zealand stock market. Since New Zealand is a small open economy with unique features such

[25] Other economic indicators that also fell to US uncertainty include output, consumption, exchange rate, commodity prices, and investment.

[26] However, the study found no significant effects of US policy uncertainty shocks on Anglo-Saxon countries and New Zealand.

as stable monetary policy regimes, smaller size, and a higher degree of trade and financial openness, one would expect its economy, and hence its stock market, to respond differently to US EPU shocks compared to the stock markets of large European economies or emerging economies.

The methodology consists of two parts. Because this essay relies on weekly data on the stock market (and EPU) indices to examine EPU spillovers on the New Zealand stock market, weekly indicators of US EPU and NZ EPU are indispensable to the analysis. A weekly EPU index for the US can be easily calculated from the readily available daily US EPU series, but a weekly EPU index for New Zealand was not available; thus, one had to be created. The first part of the methodology explains how the weekly EPU index for New Zealand is created by following Baker et al. (2016)'s news-based methodology. The second part provides details of the VAR (1)-BEKK-GARCH model that is employed to capture the return and volatility spillovers directed from NZ EPU (US EPU) to NZ equity sectors and NZSE. Overall, the findings suggest that NZ equity sectors and NZSE receive much stronger and more pronounced spillover effects from US EPU compared to the local counterpart (NZ EPU). While the return spillovers from both EPUs are somewhat similar yet limited to just a few sectors, the volatility spillovers from US EPU on NZ sectors outstrip those from the NZ EPU. For volatility spillovers, the domestically oriented sectors are relatively more vulnerable to NZ EPU, while those having export/import concentration with the US are mainly susceptible to US EPU.

This essay contributes to the literature in the following ways. First, the essay introduces a weekly EPU index for New Zealand that was previously unavailable. A monthly EPU index for the country has already been created and used by Tsui, Balli, Tan, Lau, and Hasan (2017) and Balli, Uddin, Mudassar, and Yoon (2017), respectively. A weekly NZ EPU index has, however, its own utility for academic explorations, especially for studies that rely on weekly data in order to avoid noise involved in the daily data series. The essay thus contributes to the ongoing efforts aimed at developing the country-based EPU indices (Gentzkow & Shapiro, 2010; Baker et al., 2016; Alexopoulos & Cohen, 2015). To the best of our knowledge, this research is not only the first to develop a weekly EPU index for New Zealand, but also the first to create a weekly EPU index for any country[27]. Our second contribution is to the literature that examines EPU spillovers on stock markets (Pástor & Veronesi, 2012 & 2013; Antonakakis, Chatziantoniou & Filis, 2013; Brogaard & Detzel, 2015; Bijsterbosch & Guerin, 2013; Liu & Zhang, 2015; Ko & Lee, 2015). Unlike most of this literature, which considers the spillover effects of local and foreign EPU on the domestic stock market separately, the essay simultaneously investigates the spillover effects of both EPUs on the stock market of a country, namely, New Zealand. Besides, the extant literature typically analyses EPU spillovers on the aggregate stock markets of certain large economies of Europe or those of few emerging economies. However, it remains largely unclear whether the nature of such spillover effects for different equity sectors of a small open economy. Considering New Zealand as our sample country, the essay provides evidence of EPU spillovers for the equity sectors of a small open economy, and thereby contribute to the literature.

In the literature exploring the EPU-equity sector nexus, the current research is linked closely to Yu et al. (2018) and Yu et al. (2017). While these studies, respectively, analyze the effects of EPU on the return-volatility and long-run betas of various sectors, both studies take the US stock market as their backdrop. Also, both analyses are limited to 10 US sectors and US EPU only and explore the sector performance under policy uncertainty for a large economy. In their examinations, the authors relied on the GARCH-MIDAS framework (Engle, Ghysels & Sohn, 2013) and the DCC-MIDAS framework (Colacito, Engle, & Ghysels, 2011),

[27] A notable exception is Kamber et al. (2016) that constructs and displays various uncertainty indices for New Zealand. However, this study did not create the news-based uncertainty index for New Zealand.

respectively. This essay provides evidence further to their investigations by exploring the return and volatility spillovers directed from NZ EPU (US EPU) to 15 NZ equity sectors and NZSE. This essay thus provides a sharp contrast between how the equity sectors of two very different economies respond to policy uncertainty; clearly, New Zealand is a small open economy, and the US is a much larger economy.

Finally, by considering NZ equity sectors, this essay is making a specific contribution to the literature that links US EPU with asset markets of small open economies. As mentioned above, two investigations have already been conducted on New Zealand's stock market from this perspective; they include the works by Kamber et al. (2016) and Stockammar and Österholm (2016). While both studies layout the foundation for the present work by setting a potential course of spillover effects from the US to small open economies (one of which is New Zealand), the focus of their analyses remained on how macroeconomic and financial variables, such as GDP and stock market index, in those economies responded to US EPU. Even when evaluating the stock market reaction to US EPU, both studies relied solely on the aggregate stock market index of New Zealand, with paying little attention to the sensitivity of stock market sectors. Besides, the effect of local EPU on the performance of the aggregate stock market was entirely ignored by the two reports. By analyzing New Zealand's stock market-EPU nexus, this essay captures the sensitivity of NZ equity sectors to international (US) EPU and local EPU (NZ). It thus fills the gaps left out by the two studies. In other words, unlike the two studies, the essay not only considers the spillover effects of local EPU along with US EPU but also examines these effects at the disaggregated level of the New Zealand stock market, moving further down to the NZ equity sectors.

The essay unfolds as follows: Section 4.2 introduces the extant literature on the topic. Sections 4.3 and 4.4 describe the dataset and empirical methodology, respectively. Section 4.5 reports empirical findings, and section 4.6 concludes.

4.2 Literature review

Current research in this domain has four distinct strands of literature: first, economic policy uncertainty measurement; second, EPU effect on the overall economy; third, EPU spillovers among countries; and the fourth, the influence (or spillover effects) that a domestic and international EPU have on home country's stock market. This section will address all these strands individually.

4.2.1 Measurement of economic policy uncertainty

In general, economic uncertainty exists when it is hard to predict future economic outcomes. Economic uncertainty is categorized into several classes such as domestic and foreign, general and policy-related, macro and firm-based, short and longer-term. While studying all categories may have exciting implications, this research confines itself to the definition of economic policy uncertainty given by Baker et al. (2016) as the uncertainty about who will make economic policy decisions, what and when these decisions would be made, and what would be the impact of such decisions. No matter how you define it, the fact that uncertainty is not directly observable makes its measurement a challengeable task. Therefore, current research is still searching for a better proxy (see, Bachmann et al., 2013; Bekaert et al., 2016; Bloom, 2009; Julio & Yook, 2012; Jurado et al., 2015; Rich & Tracy, 2010; Rossi & Sekhposyan, 2015; and Alexopoulos & Cohen, 2009, 2012 & 2015).

Broadly, various indicators (measures) of uncertainty, devised thus far, can be categorized into three classes (see Bloom, 2014; Bontempi et al., 2016; Moore, 2016). First is the "finance-based" approach, which uses rather advanced techniques for analyzing equity market volatility-based financial information (see, e.g., Bekaert et al., 2013; Bloom, 2009; Gilchrist, Sim, & Zakrajšek, 2014; and Knotek & Khan, 2011). Despite its enormous use, this approach essentially provides a measure of equity market uncertainty, and hence being incapable of capturing the overall uncertainty in the economy. Furthermore, these measures are not only asymmetric[28] but also connected indirectly to the overall economy (see Moore, 2016).

The second, “forecasts-based” approach estimates uncertainty by relying on the concept of the economy’s predictability, and therefore measuring it using the discrepancy between professional forecasts (see Bachmann, Elstner, & Sims, 2013; Jurado et al., 2015; Rich & Tracy, 2010; Rossi & Sekhposyan, 2015; and Scotti, 2016). This approach is based on the idea that if uncertainty rises in an economy, this should show up in the heightened disagreement among professional forecasters. Similarly, any downswings in uncertainty should accompany less dispersion among these professionals[29]. Nevertheless, even though this approach produces indicators that represent economic conditions reasonably closely, a significant drawback of the approach is that the forecast dispersion and uncertainty quite distinct concepts. While the forecast dispersion would capture the discord — how distant the forecasters' assessments are from each other — the measure may not necessarily represent the general level of uncertainty. Every forecaster could well be incredibly precise, yet a great deal of disagreement could still prevail, and vice versa. There are studies in the literature arguing that due to this crucial

[28] Increases in the measures accompany large falls in stock prices; large gains in stock prices are less common.
[29] Consensus Economics Surveys is a typical example of these professional forecasts.

distinction, forecast dispersion might not be a good proxy for uncertainty (Rich, Song, & Tracy 2012).

The third is the "text-based" approach, which can either be based on news articles or internet searches. The idea behind the news-based approach is as follows. Newspapers publish news articles about the topics of significant interest to the general public (the readers). As readers are typically interested in the events that can potentially affect their economic health, newspapers will report such events in a timely fashion. Therefore, news articles will promptly reflect any issues related to economic events, policies, and thereby any uncertainty about such issues in the form of language- that is, by using specific words. Hence, the swings in economic policy uncertainty will be accompanied by trends in counts of the news articles which contain words like the economy, policy, and uncertainty (or their variants). By far, this is the intuition behind recently developed news-based uncertainty measures; see (Gentzkow & Shapiro, 2010; Hoberg & Phillips, 2010; Boudoukh et al., 2013; Alexopoulos & Cohen, 2015; and Baker et al., 2016).

Nevertheless, remember that even though news articles are produced for the general public, these uncertainty measures capture and communicate the perception of the press (or that of journalists), not that of the general public. Therefore, news-based measures can be regarded as a journalist's view of uncertainty (Bontempi et al., 2016). However, what about the ordinary folks who look for uncertainty themselves, and who do not read newspapers instead use the internet to dig for uncertainty related information. This criticism provides the reason to see and hence measure the uncertainty from an individual's perspective; these are known as internet-search based uncertainty measures (see Bontempi et al., 2016; and Dzielinski, 2012). The underlying notion goes back to the field of economic psychology, which consistently finds that economic agents typically respond to uncertainty by increasing their search for information (see, e.g., Liemieux & Peterson, 2011). Thus, it seems natural to measure the uncertainty of individuals by analyzing their search behavior. Today the internet is the primary source of information. Therefore, it seems logical to follow that internet users (general public) manifest their perception of uncertainty by searching, more or less, for specific words related to it. Consequently, internet search volumes reflect these manifestations. Thus, the trend in internet search volume over time can be a good representative of any movements in uncertainty as perceived by the general public.

Although all approaches have their pros and cons, the text-based approaches are the most contemporary and popular ones, see (Bontempi et al., 2016; Dzielinski, 2012; Gentzkow & Shapiro, 2010; Hoberg & Phillips, 2010; Boudoukh et al., 2013; Alexopoulos & Cohen, 2015; and Baker et al., 2016; and Caldara & Iacoviello, 2018). Text-based measures offer several appealing characteristics, including consistency, broad coverage, and a clear indication of the uncertainty sources (Alexopoulos & Cohen, 2009). Besides, the shortcomings associated with traditional measures (see Jurado et al., 2015) further motivate us to develop text-based measures for New Zealand. As highlighted by (Kamber et al., 2016), New Zealand, as a text-book small open economy, is a developed nation with strong institutions, a long history of stable monetary policy, and a floating exchange rate regime; hence, New Zealand can be considered a test case.

Further, there is a considerable amount of news related data available for New Zealand. Indeed, data is an essential consideration for our empirical strategy. Finally, and most importantly, as well, New Zealand does not have a text-based economic policy uncertainty measure available as of now.

4.2.2 EPU, spillovers, and the overall economy

The second strand of literature focuses on the effects of economic policy uncertainty on the overall economy. In this domain, studies have mainly focused on US economic policy uncertainty to assess response patterns of macroeconomic indicators (e.g., Alexopoulos & Cohen, 2009; Bloom, 2009; Baker et al., 2013; Caggiano, Castelnuovo, Groshenny, 2013; Leduc & Liu, 2013; and Nodari, 2013)[30]. While the bulk of the research advocates EPU effects on domestic macroeconomic variables, some studies also support that domestic EPU can receive macroeconomic responses from other countries. Colombo (2013), for example, studies the effect of EPU in the US and the EU, as calculated by Baker et al. (2013), on economic activity in the Euro area. The study finds that shocks to US EPU have a more significant impact on economic activity in the euro area than the EU EPU. Also, Kim (2001) measured how macroeconomic policy shocks in the US can stimulate international business cycles. Lastly, the IMF (2013) investigates how changes in the US and EU EPUs impact the economic growth in other regions of the world. Overall, this literature vows in favor of the argument that economic policy uncertainty can easily influence the other economies, besides affecting the domestic economy.

4.2.3 Cross-country EPU spillovers

The third strand of literature attempts to answer the following questions: while domestic and international macroeconomic responses have been made evident, how about EPU in one country affecting EPU in another country? If there exists any, what could be the direction of such an effect? The literature in this area is somewhat sparse and at the inception stage. A study

[30] The seminal works addressing the policy uncertainty effects on the economy include Marcus (1981), Bernanke (1983), Aizenman and Marion (1991), and Rodrik (1991).

by Klößner & Sekkel (2014), which is a notable exception, reports that spillover effects contribute just over one-fourth to the EPU dynamics in 11 countries, with this contribution rising to half during the GFC. Since the onset of GFC, however, the US and the UK account for a large proportion of the spillovers, while the other countries remain recipients of EPU shocks during- and post-GFC period. The literature also sheds some light on the channels of policy spillovers.

A study by Gauvin, McLoughlin, and Reinhardt (2014) is a good example, which explores the degree to which uncertainty about developed countries ' macroeconomic policies spills over to emerging market economies through equity-and-bond flows. In this study, the effect of EPU fluctuations on equity flows differs noticeably as EPU changes shift from the US States to the EU. The inflows of both equity and bond portfolios into the EMEs abate when EPU in the US increases. In comparison, an increase in EU EPU reduces bond inflows but raises equity inflows to EMEs. The magnitude and direction of these EPU spillovers depend on the global risk level, with increased EU EPU only reducing bond inflows to EMEs when there is a high level of global risk. The extent and direction of country-specific sovereign default risk play a vital role around non-linearities involved in equity inflows; that is, increased EU EPU drives portfolio equity inflows into EMEs even when there is a high level of global risk, but this effect is limited to countries with a low level of sovereign default risk only.

A thorough investigation of the literature reveals that EPU not only has significant impacts on macroeconomic variables in the domestic economy but can also spill over to other economies' EPU. Finally, as seen from the literature, the direction of EPU spillover is from the US to other economies.

4.2.4 EPU spillovers and stock market

As mentioned earlier, research on individual and overall effects of EPU is not new (see Marcus, 1981; Bernanke, 1983; and Rodrick, 1991). However, interest has been resurgent after the 2007-2008 financial crises on how EPU can influence financial markets, especially the stock market. Most of these studies indicate that EPU has a negative influence on the stock market (Pástor & Veronesi, 2012 & 2013; Brogaard & Detzel, 2015; and Bijsterbosch & Guerin, 2013). For example, Antonakakis et al. (2013) examine the effect of macro-policy uncertainty on the economy by focusing on the complex interplay between the uncertainty and stock market performance. According to the authors, the latest financial crisis played a crucial role in turning the dynamic correlation between macroeconomic policy uncertainty and stock market returns into positive. Furthermore, the rising volatility around both policy uncertainty and equity market erodes equity returns and raises uncertainty.

Turning to the EPU spillovers for stock markets, it seems almost established that EPU exerts negative (positive) spillovers for aggregate market returns (volatility). For example, Gauvin et al. (2014) identify the spillovers of macroeconomic policy uncertainty from developed economies to emerging market economies through equity and bond flows. Antonakakis et al. (2013) find the time-varying correlation between EPU and stock-market returns in the US to be consistently negative over time, apart from the GFC. Furthermore, any increase around EPU and market volatility leads to a decline in stock market returns, but increase in EPU. On the other side, Ko and Lee (2015) demonstrate that EPU and stock prices do not always co-move for the US, Canada, France, Germany, Italy, UK, Spain, China, India, Japan, and Russia. Although the association is found generally negative, it changes over time, showing cycles of low to high frequency.

The timing of frequency shifts overlaps when US EPU co-moves with the EPU of other countries. A study by Bekiros, Gupta, and Majumdar (2016) highlights the importance of economic and firm-level uncertainty indicators in forecasting the volatility of the stock market. This study, however, cautions against employing linear models that are often fraught with misspecifications induced by parameter instability and nonlinearities. Dakhlaoui and Aloui (2016) also find the EPU-driven return spillovers for BRIC stock markets to be negative, while the volatility spillovers are found oscillating between positive and negative values. Strong evidence exists for a time-varying correlation between the US EPU and other stock markets' volatility; these correlations are found to be highly volatile during times of global economic uncertainty. Using a VAR framework, Kang and Ratti (2013) demonstrate that increases in US EPU Granger-cause the stock market return in the US to fall. Finally, for a sample of seven OECD countries, Chang et al. (2015) explore the linkage between EPU and stock markets. The authors demonstrate that volatility in the US and UK economic policies causes stock prices to fall and that the US EPU also influences global oil markets.

It is evident from the studies that the research in this area is still evolving. Though, the literature on the link between financial markets-namely stock and bond market-and EPU seems to provide mixed evidence; there are, however, some identifiable themes. For instance, it is evident that a time-varying correlation and spillover effects exist between domestic EPU and domestic and foreign stock markets; however, there is no consensus on the direction it takes, perhaps for it keeps fluctuating over time. Moreover, stock market volatility also depends upon type (i.e., component) economic uncertainty under consideration; some have a stronger link to stocks than others. More interestingly, no study has tried to explain spillovers across stock markets using EPU and/or its components. These clear messages from the literature motivate us to investigate volatility transmission (spillover effects) concerning EPU, and specific types of economic policy uncertainties-that are the EPU components.

Furthermore, literature also provides several channels through which EPU can spill over to the stock market. To explain this mechanism at a macro-level, the studies often assert that macro-policy uncertainty hurts the growth and investment level of an economy. While awaiting the elimination of uncertainty, rational economic agents postpone their investment decisions that are associated with — either wholly or partially — irreversible investments. Furthermore, EPU can lead to heightened riskiness around financial markets, potentially by lowering the value of protections introduced by the government for the markets (Pastor & Veronesi, 2012). Finally, economic uncertainty can also have an impact on interest rates, inflation, and expected risk premiums (Pastor & Veronesi 2013).

On a firm level, however, corporate investments are usually irreversible and expensive. For firms, the uncertainty that stems mainly from economic or political sources will have a significant impact on their earnings, revenues, and expenses. Any policy changes will, therefore, alter the business climate in which the firms are bound to operate, and hence their investment behaviors will be affected (Wang et al., 2014). EPU affects corporate investment by affecting the business cycle fluctuations, according to Baker et al. (2016).

It is well-known in finance that every decision has to be made with the context of uncertainty. Provided that the arrival of new information leads financial markets to make prompt adjustments to asset prices, it is no doubt that this happens through the ever-changing beliefs of the investors who are influenced by the information available to them, which too keeps changing over time. Bekaert et al. (2009), for example, assert that the uncertainty directly affects the term structure, which in turn significantly impacts the counter-cyclical-volatility of stock returns.

Theoretically, investors form their perceptions about the prevailing economic environment by relating asset prices to economic uncertainty. Therefore, a higher uncertainty around the economic landscape leads to higher fluctuations in asset prices. When face with an uncertain investment climate, risk-averse investors require a higher return (or risk premium) on their investments (see David, 1997; Veronesi, 1999). In other words, with market uncertainty going up, the protection level of investors gets higher as well (Bird & Yeung 2012). Indeed, in times of high degree of market uncertainty, investors tend to ignore the good news, while in times of low uncertainty, they continue to overlook bad news.

4.3 Data

The Thomson Reuter' DataStream is used to gather weekly data on NZ sectoral equity index prices[31]. The weekly values of US EPU are downloaded from the EPU website (www.policyuncertainty.com)[32]. The essay develops the weekly EPU index for New Zealand by following Baker et al. (2016)'s methodology. For this purpose, a global news database, Factiva[33], was used to search and collect articles related to NZ EPU. Our sample period spans from January 1997 to December 2016. The essay follows the sectoral grouping previously proposed by Balli, Balli, and Louis (2013), and Balli, Balli, and Luu (2014); a summary of this grouping is provided in Table 4-1. According to these studies, sectors belonging to the same

[31] To capture NZ EPU and US EPU spillover effects on the overall stock market, we add the NZ aggregate stock market index (NZSE) to the list of sectors.
[32] Note that the weekly index of NZ EPU reflects uncertainty for the whole week, whereas the US EPU is available at daily frequency and therefore represents uncertainty for a single day. Picking the value of US EPU on a given weekday to represent weekly US EPU would be misleading. To ensure consistency for both EPUs, we, therefore, take weekly average for the daily US EPU index and use this weekly series in our analysis.
[33] Factiva database is owned by the Dow Jones & Company.

group tend to respond homogenously to foreign (or local) shocks[34]. One will be interested to see if this is the case in our results as well.

Table 4-1 Sector groupings

Production and Industry Group
Industrials
Oil and Gas
Utilities
Consumer Goods and Services Group
Food and Beverages
Consumer Goods
Consumer Services
Health Care
Retail
Travel and Leisure
Technology, Media, and Telecom (TMT)[35] Group
Technology
Telecom
Media
Financial Group
Financials
Real Estate
Financial Services
Aggregate Stock Market (NZSE)

4.4 Methodology

Our methodology consists of two parts. The first part provides details of the news-based methodology[36] proposed by Baker et al. (2016), which we adopted to create the weekly EPU index for New Zealand. The second part describes the VAR (1)-BEKK-GARCH model, which is employed to capture the return and volatility spillovers from NZ EPU (US EPU) to NZ sectors and NZSE.

[34] Note that, throughout the text, the term 'group' refers to all the sectors included in that group.
[35] TMT is the abbreviation for the Technology, Media, and Telecom group.
[36] Among other popular uncertainty measures are Alexopoulos and Cohen (2015) and Jurado, Ludvigson, and Ng (2015).

4.4.1 The development of NZ EPU index

This section provides details of the news-based methodology of Baker et al. (2016), which we adopted to create the weekly EPU index for New Zealand. This part follows the footsteps of Tsui et al. (2017) and Balli et al. (2017), which developed and used a monthly EPU index for New Zealand, respectively. The weekly NZ EPU index covers a period from January 1997 to December 2016. Four major newspapers of New Zealand, namely The Waikato Times, The Press, The Dominion Post, and The New Zealand Herald, are selected for this purpose. In July 2002, The Dominion and The Evening Post were merged to form The Dominion Post. Thus, before July 2002, the data for The Dominion Post include both the newspapers that preceded it. The four newspapers are selected as a) they contain the largest number of articles related to EPU, and b) they have been published continuously over the entire sample period.

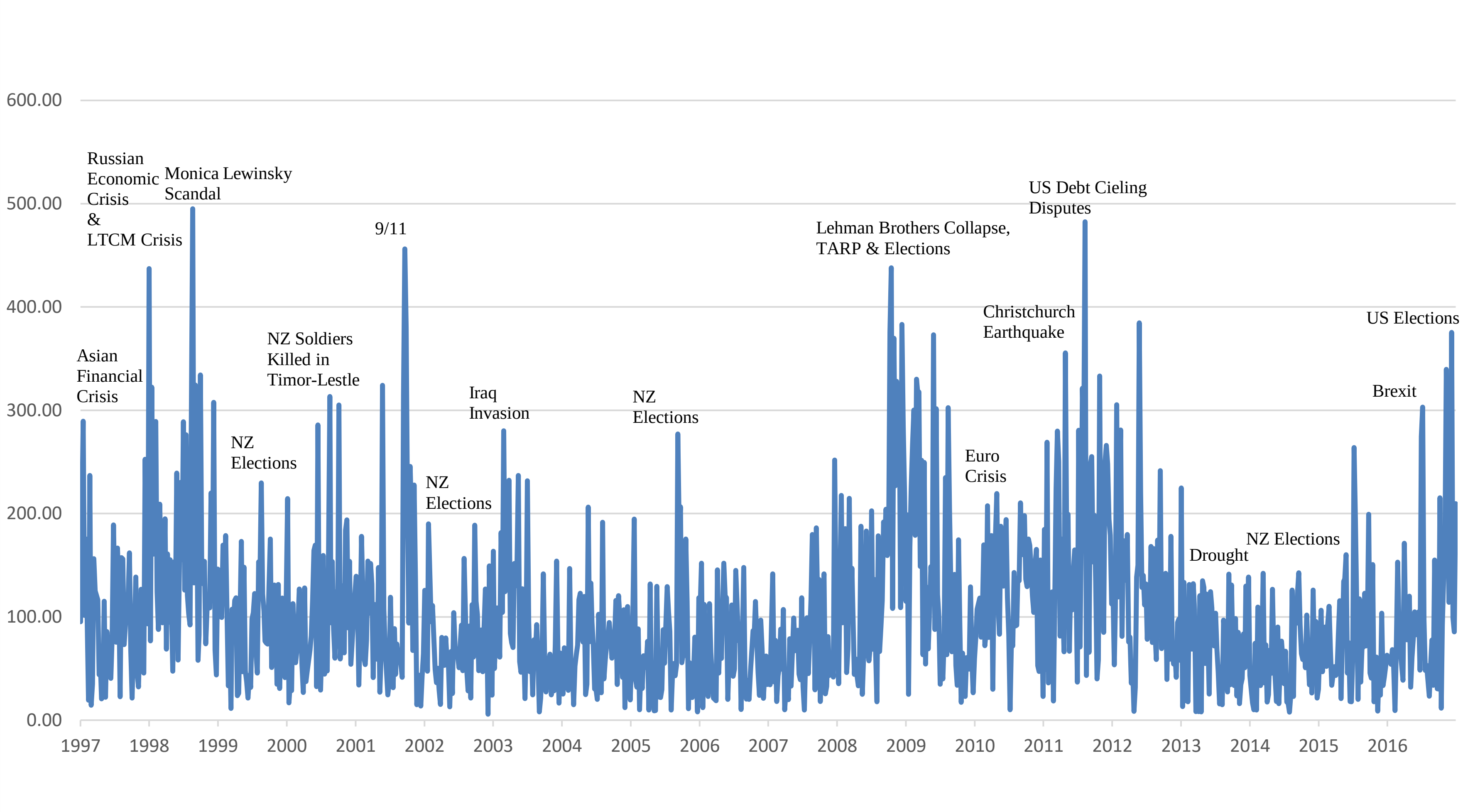
The following criterion was used to search for news articles related to the NZ EPU. A news article carries EPU related content if it contains the terms: “economy (or variants)” and “uncertain (or variants)”, and at least one of the following terms or phrases: “budget (or variants)”, “policy (or variants)”, “legislate (or variants)”, “regulate (or variants)”, “parliament (or variants)”, “reserve bank” or “rbnz[37]”. With this being the criterion, any possible string characters that represent a term or phrase are classified as "variants." The variants of the term "economy," for example, include "economic" and "economies”. The application of this criterion provides us with weekly EPU-related articles from each newspaper.

Since the weekly (raw) counts vary across both newspapers and weeks, I scale these counts by the total volume of articles published in that newspaper during a week and thus obtain

[37] Lower case acronym for ‘RBNZ’, which stands for Reserve Bank of New Zealand.

four scaled series of weekly counts. Over the sample period, each of the four scaled series is standardized to a unit standard deviation; a further average across the four standardized series turns them into a single series. Finally, the NZ EPU index is obtained by normalizing this standardized series over the sample period to a mean of 100. This final EPU index is plotted in Figure 4-1, which appears to correspond with major political and economic events happening at the local and international landscape. The two most important events, 9/11 and the 2008 GFC, for example, seem to push the EPU index to reach its highest values. Similarly, the EPU spikes around NZ elections are also quite noticeable.

Figure 4-1 Weekly EPU Index for New Zealand



Notes:
The weekly EPU index for New Zealand is the normalized weekly counts of the news articles containing "economy (or variants)" and "uncertain (or variants)", and at least one of the following terms or phrases: "budget (or variants)", "policy (or variants)", "legislate (or variants)", "regulate (or variants)", "parliament (or variants)", "reserve bank" or "rbnz". The articles Ire collected from the following four newspapers: Waikato Times, The Press, The Dominion Post, and The New Zealand Herald, over a period from January 1997 to December 2016.

4.4.2 The spillover model

This section provides the methodological details of the spillover model. Since the objective of this essay is to examine the return and volatility spillovers from local and foreign EPUs to the NZ equity sectors and NZSE, the bivariate MGARCH model appears to be the most suitable approach. More specifically, the analysis relies on the VAR (1)-BEKK-GARCH models that explicitly incorporate the direct transmission of shocks and volatility from the EPUs to NZ equity sectors and NZSE. This section begins with the presentation of the conditional means in the bivariate framework, and then introduces the BEKK-GARCH specifications under consideration.

First, the VAR model for the conditional mean specification[38] is described. For the empirical analysis on return spillovers, it is assumed that the conditional mean of returns on the NZ equity market sectors and NZ EPU (US EPU) can be described by a vector autoregressive (VAR) model. In the two-variable case, a VAR (1) model[39] can be set up as follows:

$$\mathrm{r}_{\mathrm{t}}^{\mathrm{S}} = c^{S} + a^{S}\mathrm{r}_{\mathrm{t-1}}^{\mathrm{S}} + b^{S}\mathrm{r}_{\mathrm{t-1}}^{\mathrm{NZEPU}} + \varepsilon_{\mathrm{t}}^{\mathrm{S}} \tag{1a}$$

$$\mathrm{r}_{\mathrm{t}}^{\mathrm{NZEPU}} = c^{NZEPU} + a^{NZEPU}\mathrm{r}_{\mathrm{t-1}}^{\mathrm{NZEPU}} + b^{NZEPU}\mathrm{r}_{\mathrm{t-1}}^{\mathrm{S}} + \varepsilon_{\mathrm{t}}^{\mathrm{NZEPU}} \tag{1b}$$

$$\mathrm{r}_{\mathrm{t}}^{\mathrm{S}} = c^{S} + a^{S}\mathrm{r}_{\mathrm{t-1}}^{\mathrm{S}} + b^{S}\mathrm{r}_{\mathrm{t-1}}^{\mathrm{USEPU}} + \varepsilon_{\mathrm{t}}^{\mathrm{S}} \tag{2a}$$

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[38] Our methodological approach is closely associated with Mateev (2019), which models the transmission of volatility across default swap and stock markets. We thank the anonymous referee for bringing this approach to our attention.

[39] Appropriate lag was chosen via Schwartz Information Criteria.

$$\mathrm{r_t^{USEPU}} = c^{USEPU} + a^{USEPU}\mathrm{r_{t-1}^{USEPU}} + b^{USEPU}\mathrm{r_{t-1}^{S}} + \mathrm{\varepsilon_t^{USEPU}} \tag{2b}$$

where $\mathrm{r_t^S}$, $\mathrm{r_t^{NZEPU}}$, and $\mathrm{r_t^{USEPU}}$ represent the logarithmic returns of a given NZ equity sector, NZ EPU, and US EPU series, respectively. In Eq. (1a)-(1b), the residuals, $\mathrm{\varepsilon_t^S}$ and $\mathrm{\varepsilon_t^{NZEPU}}$, are assumed to be serially uncorrelated, but the covariance E ($\mathrm{\varepsilon_t^S}$ $\mathrm{\varepsilon_t^{NZEPU}}$) needs not to be zero. Similarly, in Eq. (2a)-(2b), the residuals, $\mathrm{\varepsilon_t^S}$ and $\mathrm{\varepsilon_t^{USEPU}}$, are assumed to be serially uncorrelated, but the covariance E ($\mathrm{\varepsilon_t^S}$ $\mathrm{\varepsilon_t^{USEPU}}$) needs not to be zero. Since our primary interest is to explore the return (mean) spillovers from NZ EPU (US EPU) to NZ equity sectors and NZSE, I emphasize on the coefficients those spillover effects only. In Eq. (1a) and (2a), the coefficient a^S provide the measures of own-mean spillovers for a given sector (NZSE), whereas the coefficient b^S measures the mean spillover from NZ EPU (US EPU) to that sector or NZSE.

Now, the MGARCH models for the conditional variance are described. I model the dynamics of the conditional volatility and volatility interdependence between NZ EPU (US EPU) and NZ equity sectors and NZSE by using the full BEKK-GARCH model developed by Engle and Kroner (1995), which is suitable for accounting for not only volatility persistence of each NZ equity sector (NZSE) but also for the own- and cross-volatility spillover effects between NZ EPU (US EPU) and the sectors or NZSE.

The conditional variance-covariance matrix (H_t) of the residuals ($\mathrm{\varepsilon_t^S}$ and $\mathrm{\varepsilon_t^{NZEPU}}$) in Eq. (1a)- (1b) is defined as follows:

$$\varepsilon_t|\Omega_{t-1}\sim N(0,H_t),\ H_t \equiv \begin{bmatrix} \mathrm{h_t^{S.S}} & \mathrm{h_t^{S.NZEPU}} \\ \mathrm{h_t^{NZEPU.S}} & \mathrm{h_t^{NZEPU.NZEPU}} \end{bmatrix} \tag{3}$$

And for the residuals (ε_t^S and ε_t^{USEPU}) in Eq. (2a)- (2b), I follow the expression:

$$\varepsilon_t|\Omega_{t-1} \sim N(0, H_t),\ H_t \equiv \begin{bmatrix} h_t^{S.S} & h_t^{S.USEPU} \\ h_t^{USEPU.S} & h_t^{USEPU.USEPU} \end{bmatrix} \tag{4}$$

In each case, ε_t is the (2 × 1) vector of residuals that are obtained from the VAR model and Ω_{t-1} is the information set containing all the information available up to time (t−1). Note that different specifications of H_t will lead to different multivariate GARCH models. For instance, Engle and Kroner (1995) introduce the BEKK representation of the multivariate GARCH models by specifying the positive definite covariance matrix. Specifically, the bivariate BEKK-GARCH takes the following form:

$$H_t = CC' + A\varepsilon_t\varepsilon'_{t-1}A' + BH_{t-1}B' \tag{5}$$

where C is a (2 × 2) upper triangular matrix of constants with elements c_{ij}; A is a (2 × 2) matrix of coefficients a_{ij} that capture the effects of own shocks and cross-market shock interactions; and B is a (2 × 2) matrix of coefficients b_{ij} that capture the own volatility persistence and the volatility interactions with the EPU series. In other words, a_{ij} and b_{ij} represent, respectively, the short-run and long-run persistence effects in volatility transmission. The estimation of the BEKK-GARCH models is carried out by the quasi-maximum likelihood (QMLE) method, where the conditional distribution of ε_t is assumed to follow a joint Gaussian log-likelihood function for a sample of T observations and k = 2 in the bivariate model as follows:

$$Log.L = -\frac{1}{2}\sum_{t-1}^{T}[klog(2\pi) + ln|H_t| + \varepsilon'_{t-1}H_t^{-1}\varepsilon_t] \tag{6}$$

4.5 Empirical Findings

Table 4-2 provides descriptive statistics of NZSE and NZ sector equity returns, as well as those of the change-rate in NZ EPU (US EPU).

Table 4-2 Descriptive statistics of aggregate and sector equity indices

	Mean	Std.Dev.	Skew.	Kurt.	Q(1)	Q(4)	Q†(1)	Q†(4)	ADF
Production and Industry Group									
Industrials	0.17	2.80	-0.48	6.76	-0.00	-0.04[a]	0.23[a]	0.13[a]	-16.90[a]
Oil and Gas	0.17	3.65	0.06	6.42	0.00	-0.03	0.07[b]	0.12[a]	-33.66[a]
Utilities	0.09	2.03	0.02	4.94	-0.00	0.02	0.18[a]	0.06[a]	-30.87[a]
Consumer Goods and Services Group									
Food and Beverages	0.02	2.97	0.23	11.31	0.00	0.04	0.06[c]	0.06[a]	-34.88[a]
Consumer Goods	0.10	2.90	0.02	9.71	0.00	0.03	0.07[b]	0.07[b]	-32.30[a]
Consumer Services	0.05	2.00	-0.24	4.97	-0.00	0.00	0.20[a]	0.10[a]	-29.63[a]
Health Care	0.22	2.24	0.08	4.51	0.00	0.05	0.12[a]	0.04[a]	-33.31[a]
Retail	0.10	2.87	-0.05	8.90	0.00	0.04	0.17[a]	0.03[a]	-32.81[a]
Travel and Leisure	0.10	2.83	0.02	5.21	-0.00	-0.04	0.03	0.01	-31.38[a]
Technology, Media, and Telecom (TMT) Group									
Technology	0.46	5.77	1.29	9.81	-0.00	0.00	0.13[a]	0.00[b]	-21.58[a]
Telecom	-0.05	3.33	-0.21	5.26	-0.00	0.01	0.13[a]	0.12[a]	-36.86[a]
Media	0.08	3.25	-0.29	6.50	0.00	-0.03[a]	0.18[a]	0.19[a]	-25.56[a]
Financial Group									
Financials	0.01	1.69	-0.78	7.75	-0.00	0.04	0.27[a]	0.15[a]	-30.08[a]
Real Estate	0.00	1.49	-0.18	5.48	0.00	-0.01	0.11[a]	0.05[a]	-31.93[a]
Financial Services	0.00	2.05	-1.46	14.96	-0.00	-0.01	0.06[c]	0.02	-32.03[a]
Aggregate Stock Market (NZSE)	0.06	1.64	-0.47	6.53	-0.00	0.05	0.15[a]	0.06[a]	-31.18[a]
NZ EPU	0.18	0.97	-0.00	3.05	-0.46[a]	0.02[a]	0.04	0.02	-13.42[a]
US EPU	0.26	0.29	0.00	3.81	-0.35[a]	-0.01[a]	0.11[b]	0.05	-22.42[a]

Notes: The table provides a summary of the descriptive statistics for weekly returns (in percentage) of the sector equity indices and NZSE. The weekly average, standard deviation, kurtosis are denoted by Mean, Std. Dev., Skew., and Kurt., respectively. Q (1) and Q (4) indicate the autocorrelations of order 1 and 4 of the residual-series, respectively. Q†(1) and Q†(4) represent the autocorrelations of order 1 and 4 for squared residuals of the AR(1) process for each time series, respectively. ADF is the empirical statistic for the Augmented Dickey and Fuller (1979) test. The significance of the Ljung and Box (1978) test statistics and ADF-statistic is denoted by a, b, and c at 0.10, 0.05, and 0.01 levels, respectively.

Both the equity returns and the EPU change-rates are calculated by taking the logarithm difference of two consecutive index values. Table 4-2 also includes the results of Augmented Dickey and Fuller (1979) and Ljung and Box (1978) tests. Note that while the Technology sector produces the highest amounts of average weekly return (0.46%) and standard deviation (5.77%), the sectors in the Financials group yield the lowest returns and standard deviations. The skewness coefficient (Skew.) indicates that most of the return distributions are negatively skewed. Also, as suggested by Q(1) and Q(4), most of the equity return series are weakly serially correlated, while the NZ EPU and US EPU change-rate series exhibit a strong autocorrelation. The significance of Q†, however, indicates a strong second-moment dependence in the distribution of equity returns, suggesting the presence of conditional heteroscedasticity and, therefore, justifying our choice of using BEKK-GARCH specification for this dataset. Finally, the ADF test results reported in the last column indicate that all the return and EPU change-rate series are stationary at 1% level, suggesting that the series are suitable for the analysis.

Now I discuss the results of return and volatility spillovers between NZ EPU (US EPU) and NZ equity sectors and NZSE. First, I talk about the return spillovers from NZ EPU to NZ equity sectors (NZSE). Table 4-3 shows the estimation results for the bivariate VAR (1)-BEKK-GARCH models, with each model including a given NZ equity sector (or NZSE) and NZ EPU. Because our primary interest is to explore the return and volatility spillovers directed from NZ EPU to NZ equity sectors (NZSE) as well as those from within each sector, I will only emphasize on those spillover effects. The results of the mean equations with NZ EPU, i.e., the VAR system comprised of Eq.(1a) and Eq. (1b), are presented in Panel A of Table 4-3.

Table 4-3 Return and volatility spillovers from NZ EPU and NZ sectors

Sector group	Production and Industry Group			Consumer Goods and Services Group						Technology, Media, and Telecom (TMT) Group			Financial Group			
Sector	Industrials	Oil and Gas	Utilities	Food and Beverages	Consumer Goods	Consumer Services	Health Care	Retail	Travel and Leisure	Technology	Telecom	Media	Financials	Real Estate	Financial Services	NZSE
Panel A: Conditional mean																
c^{S}	0.003[a]	0.002[c]	0.001[b]	0.000	0.001	0.001[c]	0.002[a]	0.001	0.001	0.001	0.000	0.001[c]	0.001[b]	0.001[c]	0.001[c]	0.001[a]
a^{S}	-0.033	-0.043	0.008	-0.049	0.013	0.107[a]	-0.015	0.024	0.019	0.010	-0.119[a]	-0.007	0.053	0.017	0.023	0.043
b^{S}	0.000	-0.002[b]	0.000	0.000	0.000	-0.001[c]	-0.001	-0.001	0.000	0.000	-0.001	-0.002[b]	0.000	0.000	0.000	0.000
c^{NZEPU}	0.004	0.006	0.006	0.008	0.014	0.006	0.000	0.011	0.008	-0.003	0.006	0.007	0.003	-0.001	0.006	0.009
a^{NZEPU}	-0.507[a]	-0.505[a]	-0.495[a]	-0.503[a]	-0.508[a]	-0.500a	-0.502[a]	-0.505[a]	-0.509[a]	-0.559[a]	-0.508[a]	-0.495[a]	-0.509[a]	-0.506[a]	-0.501[a]	-0.505[a]
b^{NZEPU}	-0.696	0.521	-0.961	-0.189	-1.178	-0.640	1.150	-0.626	0.598	-0.456	-0.476	-0.016	-1.985	-1.307	-0.849	-1.129
Panel B: Conditional Variance																
c_{11}	-0.008	0.035	-0.019	-0.028	-0.027	0.018	-0.022	0.027	0.027	0.054[a]	-0.019	-0.030	-0.007	-0.014	-0.039	-0.015
c_{21}	-0.101	0.037	0.009	-0.001	0.015	-0.024	-0.007	0.027	-0.003	0.045	0.052	-0.011	0.065	0.033	-0.034	0.034
c_{22}	0.851[a]	0.817[a]	0.832[a]	0.832[a]	0.809[a]	0.845[a]	0.816[a]	0.830[a]	0.813[a]	0.803[a]	0.812[a]	0.823[a]	0.836[a]	0.823[a]	0.811[a]	0.853[a]
a_{11}	0.483[a]	-0.247[a]	0.329[a]	0.323[a]	0.278[a]	-0.443[a]	0.237[a]	-0.293[a]	0.167[b]	-0.334[a]	0.447[a]	-0.405[a]	-0.514[a]	-0.272[a]	-0.044	-0.464[a]
a_{12}	0.001	0.000	0.000	0.000	-0.003[b]	0.001	0.000	0.000	0.000	-0.005	0.000	-0.001	-0.001	-0.001	-0.001	0.000
a_{21}	-3.408	0.078	0.309	-1.109	3.059[c]	0.361	-3.319[c]	0.392	0.543	0.475	0.391	2.335[c]	2.662	-2.443	0.044	-0.140
a_{22}	0.414[a]	0.500[a]	0.479[a]	0.477[a]	0.497[a]	0.454[a]	0.506[a]	-0.484[a]	-0.512[a]	0.554[a]	0.495[a]	-0.492[a]	0.443[a]	0.491[a]	0.516[a]	0.434[a]
b_{11}	0.799[a]	-0.001	0.000	-0.027	-0.196	0.000	0.001	0.015	0.001	0.000	0.666[a]	0.000	-0.777[a]	0.000	-0.067	0.000
b_{12}	-0.005	0.003	-0.003	0.000	-0.005	0.000	-0.003	0.000	0.009	-0.005	-0.006	0.000	0.001	0.000	0.000	0.000
b_{21}	-1.761	0.028	0.023	0.296	-2.734	-0.001	0.029	0.212	-0.002	-0.077	-2.023	0.000	-0.912	0.011	-0.329	-0.020
b_{22}	0.040	-0.095	0.041	-0.015	-0.119	-0.002	0.041	0.004	-0.057	0.068	-0.154	0.000	-0.173	0.021	0.002	-0.015
Log.L	1141.53	786.63	1361.67	1078.40	1052.61	1404.75	1238.44	1073.12	1005.19	174.70	860.14	912.39	1656.73	1706.79	1022.68	1647.33

Notes: In every pair, the superscripts S and NZEPU represent a given sector (or NZSE) and the New Zealand EPU index, respectively. The first series in our bivariate framework refers to the sector (NZSE). c_{ij} represents coefficients of constants. a_{ij} represents coefficients that capture the effects of own shocks and cross-market shock interactions. b_{ij} represents coefficients that capture the own volatility persistence and the volatility interactions with the NZ EPU series. a, b, and c indicate significance at 1%, 5%, and 10% levels. Standard errors are skipped to conserve space but are available on request.

Note that the current returns of only Consumers Services and Telecom sectors depend upon their own past returns (a^S), while those of the Oil and Gas, Consumer Services, and Media sectors depend upon past changes in NZ EPU (b^S). Both Consumer Services and Media sectors are linked more closely to the domestic economic policies, and their returns are therefore significantly predicted by NZ EPU. The Oil and Gas sector, however, is generally more linked to the foreign policy changes, but is also one of the critical sectors of the NZ economy and thus is bound to be sensitive by any changes around NZ EPU. These findings indicate that short-term predictability of returns exists for only a few NZ sectors over time. Similarly, the NZ EPU also seems to predict the returns of only a few sectors. Notably, the past lag of NZ EPU and NZSE do not predict the current returns of NZSE. Finally, a few cases of significant a^S in the return spillover results also support the weak autocorrelation given in Table 4-2.

As to the conditional variance equations, the results shown in Panel B of Table 4-3 indicate that the current conditional volatility of all NZ equity sectors (except Financial Services) and NZSE is strongly influenced by their own past shocks (a_{11}), while only that of Industrials, Telecom, and Financials sectors is determined by their past volatility (b_{11}). On the other hand, there is no role of NZ EPU's past volatility (b_{21}) on the current volatility dynamics of NZ equity sectors (NZSE). Only for the Consumer Goods, Health Care, and Media sectors, the past shocks of NZ EPU are an essential driver of the current conditional volatility (a_{21}). Since these three sectors are driven mainly by domestic demand, their volatility seems tightly linked with local EPU shocks.

Table 4-4 Return and volatility spillovers from US EPU and NZ sectors

Sector group	Production and Industry Group			Consumer Goods and Services Group						Technology, Media, and Telecom (TMT) Group			Financial Group			
Sector	Industrials	Oil and Gas	Utilities	Food and Beverages	Consumer Goods	Consumer Services	Health Care	Retail	Travel and Leisure	Technology	Telecom	Media	Financials	Real Estate	Financial Services	NZSE
Panel A: Conditional mean																
c^{S}	0.003^{a}	0.002^{b}	0.001^{b}	0.000	0.001	0.001^{b}	0.002^{a}	0.001	0.001	0.001	0.000	0.002^{c}	0.001^{b}	0.001^{b}	0.001^{c}	0.001^{a}
a^{S}	-0.034	-0.042	0.010	-0.044	0.017	0.103^{a}	-0.021	0.020	0.019	0.018	-0.132^{a}	-0.024	0.043	0.004	0.013	0.037
b^{S}	0.000	-0.006^{c}	-0.003^{c}	-0.001	-0.002	-0.001	0.001	0.000	-0.002	-0.004	-0.001	0.002	-0.003^{b}	-0.002^{c}	-0.004	-0.002
c^{USEPU}	-0.002	-0.005	-0.001	-0.003	-0.001	-0.004	-0.001	-0.006	-0.003	0.002	-0.002	-0.003	-0.006	-0.002	-0.009	-0.003
a^{USEPU}	-0.385^{a}	-0.386^{a}	-0.389^{a}	-0.392^{a}	-0.381^{a}	-0.380^{a}	-0.385^{a}	-0.376^{a}	-0.388^{a}	-0.337^{a}	-0.380^{a}	-0.382^{a}	-0.385^{a}	-0.385^{a}	-0.377^{a}	-0.388^{a}
b^{USEPU}	-0.738^{b}	-0.291	-1.322^{c}	-0.668^{c}	-0.490	-1.141^{b}	-0.412	0.166	-0.504	-0.621^{a}	-0.661^{b}	-0.482^{c}	-0.561	-0.402	0.063	-1.567^{a}
Panel B: Conditional Variance																
c_{11}	0.007	0.019^{a}	-0.017^{a}	0.027^{a}	0.028^{a}	-0.005	-0.021^{a}	0.027^{a}	0.028^{a}	0.016^{a}	-0.021^{a}	-0.011^{a}	0.002^{a}	-0.008^{c}	-0.039^{a}	-0.004^{a}
c_{21}	0.017	-0.083^{c}	-0.021	-0.020	0.014	-0.155	-0.046	0.026	-0.010	0.248^{a}	0.129^{b}	0.116^{b}	0.169^{a}	-0.169	0.017	0.218^{a}
c_{22}	-0.235^{a}	-0.178^{a}	-0.302^{a}	-0.163^{a}	-0.151^{a}	-0.232^{b}	-0.125^{a}	-0.120^{a}	-0.177^{a}	0.021	-0.128	-0.188^{a}	-0.127^{a}	-0.221^{a}	-0.178^{a}	-0.082
a_{11}	0.525^{a}	-0.344^{a}	0.337^{a}	-0.448^{a}	0.304^{a}	-0.437^{a}	0.337^{a}	0.345^{a}	0.173^{b}	-0.463^{a}	0.431^{a}	0.359^{a}	0.438^{a}	-0.314^{a}	0.025	0.328^{a}
a_{12}	-0.003	0.006	0.007^{c}	0.010^{b}	0.002	-0.003	-0.006	0.011^{c}	0.000	0.001	0.001	-0.006	-0.012^{a}	-0.001	-0.002	-0.006^{b}
a_{21}	-0.591	-1.056^{b}	-1.276	-0.987^{b}	-0.029	2.161^{a}	0.488	0.292	-0.954	0.264	1.190^{a}	1.208^{b}	-3.561^{a}	4.327^{a}	0.674^{b}	4.343^{a}
a_{22}	-0.375^{a}	0.356^{a}	-0.397^{a}	-0.383^{a}	-0.362^{a}	-0.281^{a}	0.326^{a}	-0.306^{a}	-0.400^{a}	0.467^{a}	0.399^{a}	0.352^{a}	-0.277^{a}	0.421^{a}	0.410^{a}	0.352^{a}
b_{11}	0.768^{a}	-0.756^{a}	0.001	0.035	0.003	-0.719^{a}	-0.003	0.004	0.000	-0.279^{a}	0.640^{a}	0.828^{a}	0.804^{a}	0.010	-0.068	0.814^{a}
b_{12}	0.027	-0.023^{b}	0.026	-0.001	0.008	0.027^{b}	0.010	0.005	-0.003	-0.159^{a}	0.009	0.028^{a}	-0.012^{a}	-0.035^{a}	0.001	0.019^{a}
b_{21}	1.609^{c}	0.703^{b}	-0.007	-0.230	0.059	-1.774^{c}	0.167	0.020	-0.035	0.338	3.216^{a}	-1.126^{b}	1.466^{a}	-0.052	0.001	-1.782^{a}
b_{22}	-0.574^{a}	-0.712^{a}	-0.063	-0.780^{a}	-0.813^{a}	-0.427^{b}	-0.856^{a}	-0.876^{a}	-0.741^{a}	0.266^{a}	-0.644^{a}	0.634^{a}	0.703^{a}	0.302^{c}	-0.736^{a}	0.579^{a}
Log.L	2191.68	1830.52	2412.79	2130.92	2097.72	2456.49	2291.51	2120.15	2052.02	746.21	1911.45	1958.53	2706.51	2751.71	2070.22	2702.75

Notes: In every pair, the superscripts S and USEPU represent the sector (NZSE) and the EPU index of the United States, respectively. The first series in our bivariate framework refers to the sector (or NZSE). c_{ij} represents coefficients of constants. a_{ij} represents coefficients that capture the effects of own shocks and cross-market shock interactions. b_{ij} represents coefficients that capture the own volatility persistence and the volatility interactions with the US EPU series. a, b, and c indicate significance at 1%, 5%, and 10% levels. Standard errors are skipped to conserve space but are available on request.

Now I turn to the return and volatility spillover effects between US EPU and NZ equity sectors and NZSE. Table 4-4 presents these results. Once again, our key focus will remain on the return and volatility spillovers directed from US EPU to NZ equity sectors (NZSE), as well as those from within each sector (NZSE). Panel A of Table 4-4 contains the results of mean equations with US EPU, i.e., the VAR system of Eq. (2a) and Eq. (2b). Just like Table 4-3, the current returns of only Consumers Services and Telecom sectors depend upon their own past returns (a^S), while, in contrast, those of the Oil and Gas, Utilities, Financials, and Real Estate sectors depend upon past changes in US EPU (b^S). Just like Table 4-3, the short-term predictability in NZ sectoral returns through time is only limited to Consumer Services and Telecom sectors. The short-term predictability of the US EPU is, however, present for four sectors, namely Oil and Gas, Utilities, Financials, and Real Estate. Since these sectors are relatively more vulnerable to global economic policy changes, the predominant role of US EPU in predicting their returns is quite intuitive. Here again, the past lag of US EPU and NZSE do not predict the current returns of NZSE.

Regarding the conditional variance equations, the results shown in Panel B of Table 4-4 indicate that the current conditional volatility of all the equity sectors (except Financial Services) and NZSE is strongly influenced by their own past shocks (a_{11}). Thus, the short-run persistence in sectoral (NZSE) volatility due to their own shocks is found to be pronounced for almost all the sectors (NZSE). On the other hand, for Industrials, Oil and Gas, Consumer Services, Technology, Telecom, Media, and Financials sectors, as well as NZSE, the current conditional volatility is influenced by their own past conditional volatility (b_{11}). The past shocks in US EPU are important for driving the current conditional volatility of the sectors like Oil and Gas, Food and Beverages, Consumer Services, Telecom, Media, Financials, and Real Estates, and NZSE (a_{21}). However, unlike NZ EPU, whose past conditional volatility was irrelevant for the current conditional volatility of NZ sectors, the past conditional volatility of US EPU seems to drive the current conditional volatility of some NZ sectors of an aggregate equity index (b_{21}). Specifically, the past volatility of US EPU significantly drives the current conditional volatility of Industrials, Oil and Gas, Consumer Services, Telecom, Media, Financials, and NZSE.

Interesting groupings emerge from the sectoral analysis with regards to the EPU effects. Each sector in the Consumer Goods and Services group, apart from Consumer Services, experiences either nothing or only volatility spillovers from just one EPU. Like, Retail and Travel and Leisure sectors are hurt by none of the EPUs. Consumer Goods and Health Care (Food and Beverages) sectors receive volatility spillovers from NZ EPU (US EPU) shocks only. It is only the Consumer Services sector that is exposed to both EPUs; it experiences return spillover from NZ EPU and volatility spillovers from US EPU. Relatively large exposure of this sector from US EPU can be understood from the fact that this is the only sector in the group that deals in non-essential services, which the consumers can easily avoid without having severe consequences for their well-being, especially when faced with uncertain economic conditions.

Moreover, US EPU's driving effect on the volatility of the Consumer Services sector might be because many of the consumer services, besides their domestic use, are exported to the US. Excluding this sector, however, the Consumer Goods and Services group appears to be the most resilient group among all sector groups. This may be because most of the sectors included this group deal in public utilities and essential items, whose output demand generally remains stable, even during economic conditions that are highly uncertain, lending stability to their income streams. The stable nature of these sectors' returns makes them relatively less responsive to either of the EPUs.

In contrast, the sectors composing Production and Industry, TMT, and Financial groups are more vulnerable to US EPU. In the Production and Industry group, Oil and Gas appear to be the sector most susceptible to US EPU (even though it experiences return spillover from NZ EPU), while Utilities and Industrial sectors are only prone to volatility spillovers from US EPU, respectively. Similarly, in the TMT group, while the Technology sector is exposed to none of the EPUs, Telecom and Media sectors receive strong volatility spillovers from US EPU, even though the Media sector experiences return and volatility spillovers from NZ EPU. Clearly, the sectors in the Financial group are hit only by US EPU. Financials and Real Estate sectors are exposed to both return and volatility spillovers from US EPU, whereas the Financial Services sector's volatility shocks only driven by US EPU. Finally, the NZSE experiences a significant amount of volatility spillovers from US EPU but shows no sensitivity to the local counterpart- as witnessed from Table 4-3.

Another important aspect of our findings relates to the coefficient signs of volatility spillovers. As mentioned earlier, ideally, the coefficients of return spillovers should be negative, and those of volatility spillovers be positive (Pastor and Veronesi, 2012). While all the significant return spillovers have negative coefficients in our case, there are some instances where the coefficients of volatility spillovers have turned out to be negative. For instance, the coefficient of volatility spillover directed from US EPU' shocks to the aggregate NZSE is negative. The negative coefficient can occur perhaps because a higher US EPU has negative impacts on the US economy and financial markets, which could be perceived as a "good news" for the New Zealand stock market. Obtaining such "good news" investors operating in the NZ stock market may exhibit positive attitudes towards their domestic stock markets, and this may lead to lower market volatility. With this explanation in mind, some recent studies have documented negative volatility spillovers from US EPU to emerging market economies. For example, Dakhlaoui and Aloui (2016) found a volatility spillover effect from US EPU to BRIC stock markets to oscillate between positive and negative values. Similarly, Su, Fang, and Yin (2019) found the effect of US EPU on the volatility of emerging-market economies to be negative, indicating that a higher US EPU is associated with lower volatility. Regarding sectoral analysis, the negative coefficients of volatility spillovers are also consistent, although to a limited extent, with Yu et al. (2018) and Yu et al. (2017) with US context.

Overall, the findings suggest that NZ equity sectors and NZSE receive relatively stronger and pronounced spillover effects from US EPU as compared to the local counterpart (NZ EPU). While return spillovers from both EPUs are somewhat similar, yet limited, to a few sectors, the impact of US EPU on NZ sectors' volatility well surpasses that of the NZ EPU. In general, for volatility spillovers, the domestically oriented sectors are vulnerable to NZ EPU, while the export/import oriented sectors are susceptible to US EPU. Based on the findings of this essay, investors, financial analysts, and policymakers should remain vigilant in their decision-making processes regarding the impact of local and foreign EPUs on the various sectors of the New Zealand stock market.

4.6 Concluding remarks

This research helps to understand the responsiveness of various sectors of the New Zealand stock market to both local and foreign EPUs. Going one step further from the examinations that generally relate the aggregate equity index with the domestic or US EPUs, I explored the spillovers of local and foreign EPU on sectoral equity indices. As our results suggest, the performance of New Zealand's stock market is mainly linked to US EPU, implying that the market participants in the NZ stock market tend to track reasonably closely the shocks induced by US EPU, thereby manifest their EPU-driven sentiments in the form return and spillovers of volatility.

Upon considering New Zealand's economic ties with the United States, the results appear to be quite intuitive. The US is not only one of New Zealand's largest trading partners, but it is also the second-highest contributor of foreign direct investment (FDI) to the country after Australia. It seems that due to the strong economic linkages, equity investors are more concerned about EPU around the US economy than they are about New Zealand. That might be the reason why the three sector-groups, namely Production and Business, TMT, Financials, are predominantly vulnerable to US EPU. The fact that the Financials group is most affected could be an indication of the fact that nearly one-third of New Zealand's inbound FDI goes to the financial sector.

Our findings carry implications for equity investors, particularly for those institutional investors aiming to exploit diversification opportunities by simultaneously investing in the financial sectors (and aggregate market indices) of both countries. The finding that the US stock market is strongly responsive to US EPU shocks (Baker et al., 2016; Pástor & Veronesi, 2012 & 2013) may be considered while sorting the investment vehicles that are associated with the aggregate stock market. Because the present essay also noted that New Zealand's aggregate equity market is highly vulnerable to US EPU, any potential for diversification between the two stock markets may be restricted. Therefore, institutional investors taking simultaneous portfolio positions in both the stock markets should be cautious. Similarly, close attention should also be paid when investing in the financial sectors of both countries, as Yu et al. (2017) found out that US EPU strongly drives the market risk of the US financial sector. Lucrative diversification opportunities may, however, exist across less competitive sectors of the New

Zealand stock market, such as Retail, Travel and Leisure, and Technology sectors due to their resilience against both local and US EPU.

Future research may consider expanding to include other small open economies. Following Stockammar and Österholm (2016), a sample of small open economies such as Australia, Canada, Denmark, Finland, Sweden, Iceland, and Mexico may be considered for this purpose. Based on our findings and considering the small-open nature of these economies, the countries having a stronger (weaker) economic linkage with the US would be expected to experience stronger (weaker) spillovers from the US EPU as compared to the local EPU.

5 CHAPTER 5 CONCLUSION

This last chapter of the thesis includes three sections. The first section provides a summary of the key findings from each of the three essays and highlights the contribution that each essay provides to the current body of literature. This section also includes the implications that each essay offers to the policymakers and investors. The second section lists the limitations of the three essays, while the last section points to some of the potential avenues for further research in this area.

5.1 Key findings, contributions, and policy implications

5.1.1 Essay one

Based on the conflict contagion literature, which has often reported the role of information flows in spreading geopolitical conflicts across borders, the first essay estimates the transmission of GPU across 19 countries and discusses the bilateral and country-specific drivers of this transmission. To this end, the news-based GPU indices for 18 emerging economies and the United States, constructed by Caldara and Iacoviello (2018), were used. The spillover model of Diebold and Yilmaz (2012) was employed for this purpose. A graphic description of the spillover results was achieved through Gephi – an open-source graphics visualization software. The exploration of the potential drivers of GPU transmission was undertaken via a cross-sectional regression framework. Finally, the total GPU transmission is split into short- and long-term components by employing the recently introduced frequency-connectedness model of Barunik and Krehlik (2018). The short- and long-term, pairwise GPU transmissions are also subjected to the cross-sectional regression.

The key findings of the first essay follow. A considerable amount of GPU transmission has been observed across our sample countries. In general, countries that send more GPU shocks to others are also the ones that receive more, while the amounts of transmission being slightly higher than those of reception. The United States, Russia, Brazil, China, and Saudi Arabia appear to be the largest contributors (receivers) of GPU shocks to (from) the rest of the countries. The graphic description of the spillover results suggested that geographic clustering is present among the GPU of sample countries. With a few exceptions, a higher amount of GPU transmission is observed among countries located in the same geographic region. The amount of GPU transmission is even higher for the neighboring countries. In general, the closer (farther) the countries, the higher (lower) the amount of GPU transmission among them. Most notably, countries with larger geographical sizes play a leading role in the transmission of GPU. Interestingly, aside from the pacific benefits of trade found in the literature (Oneal & Russett, 1999), the first essay suggests a higher magnitude of GPU transmission between trading partners.

The emergence of geographic clustering from the GPU transmission results required further explanation of these results. Under a gravity model framework, the pairwise GPU transmissions are explained through a cross-sectional regression. This empirical exercise indicates the critical role played by bilateral and country-specific factors in transmitting GPU shocks from one country to another. Specifically, bilateral trade and border sharing significantly increase the transmission of GPU shocks between two countries, while this transmission appears to be decreased by the common distance. Further, a transmitting country's fiscal imbalance and geographical size, as well as the debt burden of both countries, tend to increase the transmission of GPU between two countries.

The total GPU transmission is divided into short-and long-term components using the frequency connectedness model of Barunik and Krehlik (2018). Although the results obtained for short- and long-term GPU transmission are somewhat similar to those for total GPU transmission, the division exercise reveals some additional features. First, the total and pairwise estimates for short-term GPU transmission are remarkably higher than those for the long-term, indicating that the GPU transmission becomes weaker as we move from short- to long-term time horizons. Second, as the magnitude of GPU transmission weakens, the bilateral and country-specific drivers also become less critical. Third, while the indicator of geographic proximity (border sharing and common distance) are important drivers of overall and short-term GPU transmissions, they appear to be irrelevant for the transmission of GPU over the long-term horizons.

The first essay contributes to the literature in the following ways. First, the essay suggests another viewpoint by examining the transmission of GPU in the form of information flows directly emerging from geopolitical conflicts. This viewpoint is slightly different from the existing literature that so far has considered information flows responsible for the propagation of physical conflicts (Beiser, 2013; Hill & Rothchild, 1986; Weidmann, 2015). On the other hand, this research concludes that the information content of news-articles is responsible for the transmission of geopolitical uncertainty across borders, without explaining whether that uncertainty would lead to the spread of physical conflicts. Second, although the primary interest of this research pertains to the factors that determine the transmission of GPU across countries, one may be tempted to utilize the suggested factors for forecasting the direction of GPU transmission from one country to another. While those factors could prove helpful in such predictive endeavors, they may not provide much utility for predicting the actual (physical) spread of geopolitical conflicts. For such forecasting endeavors, reference should be made to the interstate-conflict studies which offer dichotomous or probabilistic predictions on individual conflicts, and which also aim to suggest conditions most conducive to geopolitical conflicts (Fearon & Laitin, 2003; Glaser, 2000; Huth, 2009; Powell, 2004). Third, rather than using a latent variable such as cross-country incidents signifying the transmission of information, this essay tracks real-time information flows via news-based GPU indices developed by Caldara and Iacoviello (2018). The GPU indices will likely increase the estimation accuracy of GPU transmission by resolving the data imperfections that were typically found in the previous interstate-conflict studies (e.g., Chadefaux, 2014). Fourth, contrary to the previous studies (e.g., Chadefaux, 2014), which aimed at predicting wars by relying on a measure of geopolitical tensions, this essay indicates the bilateral linkages and country-specific driving the transmission of GPU, and thus provides a better explanation of the phenomenon.

The results of the first essay have important implications for policymakers, investors, and corporations operating in a multi-country context. Institutional investors and multinational corporations take the decisions often involve making assumptions and projections about the geopolitical complexities of a country, region, or even the international environment. The geographical clustering of GPU suggested by this essay could be particularly insightful for these global players. By understanding the way countries are related to one another within a cluster, the dominant players within each cluster, as well as the countries that are source/target of geopolitical uncertainty, would help them make well-informed decisions. The understanding gained through regional clustering would allow them to formulate methods for risk management and thereby better evaluate investment decisions. Guided by the geographical clustering suggested by this essay, for instance, the managers and investors could buy political violence (terrorism) insurance for investments made in the countries/regions which experience a high concentration of GPU and hence could well protect their investments. The bilateral linkages and country-specific indicators suggested in this essay may also be useful for them in predicting the course of GPU transmission between the two countries. These factors may also help improve the assessments about a country's susceptibility or resilience against external GPU shocks.

Policymakers may also refer to this work while designing national security policies or taking counter-terrorism initiatives. This essay asks policymakers of a country to remain attentive to the geopolitical events taking place in their neighborhood as well as those involving their trading partners. GPUs triggered by such events can have adverse consequences on their own country's geopolitical landscape. Since it is almost impossible to shrink bilateral trade or/and manipulate geographic factors, improve fiscal imbalances, reduce debt burdens, and strengthen the domestic economy may be a few measures that can be taken to foster the resilience of a country against international GPU shocks.

5.1.2 Essay two

Studies in the extant literature have examined the impact of US uncertainty on international stock markets without paying much attention to the correlation between the US and other stock markets. The second essay examines the role of US uncertainty in driving the US stock markets spillover to global stock markets, after controlling for market correlation. To this end, a wide range of stock markets around the world, as well as three news-based uncertainties from the US, namely, EPU, EMU, EMV, have been considered. The essay found that the US uncertainties significantly cause the spillovers from the US to global stock markets. This causality from US uncertainties depends upon certain country-characteristics. Specifically, the US uncertainties explain better the spillovers between US and target countries, when those target countries have a higher degree of financial openness, trade linkage with the US, and vulnerable fiscal position. Improved levels of stock market development in the target countries, however, mitigate their stock markets' vulnerability to the US uncertainty shocks.

This essay provides the following contributions to the broader debate that connects foreign and local uncertainties to domestic stock markets (see, e.g., Boutchkova et al., 2012; Pastor & Veronesi, 2012 & 2013; and Smales, 2016). First, global evidence is provided on how US uncertainties drive spillovers between the US and other stock markets; the evidence goes well beyond individual stock markets and regions, which was the focus of previous research. The second contribution of the essay addresses how uncertainties in general, and US uncertainties, in particular, cause movements in international stock markets. In contrast to previous research which pays little attention to the correlation between the stock markets while investigating the impact of uncertainty on a given stock market (Li & Peng, 2017; Sum, 2012; Colombo, 2013; Dakhlaoui & Aloui, 2016), this essay considers the effect of US uncertainties on global stock markets after controlling for the time-varying correlation between the US and a given stock market.

Another contribution of this essay is to explore the link between news-based measures of uncertainty and asset markets. While numerous studies are available that relate news-based EPU to stock market returns and volatility (e.g., Hammoudeh & McAleer, 2015), and stock-bond market correlations (Li, Zhang, & Gao, 2015), such studies are often conducted within a domestic context. Furthermore, although EPU partly captures the uncertainty surrounding the US stock market, efforts have been made recently to develop news-based measures of uncertainty that track uncertainty in the US stock market more precisely and are therefore gaining popularity. In this essay, two such newly developed measures, namely EMU and EMV, along with EPU, have been considered to provide international evidence on the power of US print for global stock markets.

Finally, and most importantly, this essay moves the US uncertainty-global stock market nexus literature (for instance, Phan et al., 2018) one-step further by indicating the potential factors that explain the transmission of uncertainty shocks within this nexus. Specifically, this essay provides evidence that country-specific macroeconomic/financial indicators, such as trade and financial openness, fiscal imbalance, and stock market development, determine the vulnerability of global stock markets to US uncertainty shocks. Trung (2019) documents similar country characteristics as the determinants of a given economy's vulnerability to US EPU shocks, yet the relevance of those characteristics for the stock market vulnerability remained unexplored. The essay fills this gap.

The findings of the second essay carry significant implications for investors and policymakers. It has been argued in the literature (Trung, 2019) that countries with a higher degree of trade openness are likely to grow faster. However, a country's trade openness with a specific partner country could make the country's economy, and thus its financial markets, more integrated with those of the trading partner. In this regard, our results suggest that despite academic evidence of potential gains to the overall economy, trade openness with a specific country, and particularly with a large economy such as the US, could well amplify the stock market spillovers induced from economic and financial uncertainty of the partner country. This implies that when it comes to trade openness, countries should strive for trade diversification to avoid their bilateral trade becoming too concentrated on a few trading partners. In this way, trade diversification could allow countries to preserve the benefits of trade while minimizing their stock markets' exposure from external uncertainty shocks.

Our findings also suggest a similar amplification role played by higher levels of financial openness and fiscal imbalances (though only significant in the case of spillover vulnerability due to EPU) in the countries. Increased financial openness is related to more effective financial regulation and more transparent financial markets. Capital markets with such attractive features draw large amounts of capital from around the world. Empirical evidence shows that uncertainty is a source of volatility in global capital flows (Converse, 2018) and that capital flows serve as a potential channel through which uncertainties may cause global stock market spillovers (Gauvin, McLoughlin, & Reinhardt, 2014). Investors and policymakers should, therefore, take into account the degree of financial openness in a country's financial system, as well as the capital flows coming from the US to that country, since these two factors could well combine to potentially amplify the uncertainty-generated stock market spillovers from the US to the stock markets of such a country.

Similarly, weak fiscal imbalances reflect poor economic governance, which is likely to translate into uncertainty around macro-economic policies. Consequently, stock markets of countries with more uncertain macro-economic conditions are more vulnerable to uncertainty-generated stock market spillovers from the US. Investors and policymakers should, therefore, consider the exacerbating character of a host country's fiscal imbalances for stock market spillovers that are due to uncertainty-related shocks in the US equity market, and thus take appropriate actions to mitigate this impact.

Finally, the finding that developed stock markets appear to be resilient against uncertainty-driven spillovers is quite intuitive. Developed stock markets typically have measures in place with regards to investor protection and capital controls, which increase their immunity against external uncertainty shocks. This implies that while investors should consider investing in developed stock markets, policymakers should continue to take steps towards stock market development.

Overall, this essay asks international investors and policymakers to pay close attention to the finding that after controlling for the correlation between the US and a given country's stock market, the driving effect of US uncertainties for the stock market is linked to specific features of the host country such as the trade openness with the US, financial openness, fiscal imbalance, and the degree of stock market development.

5.1.3 Essay three

The third essay introduces a weekly index of economic policy uncertainty (EPU) for New Zealand and examines the return and volatility spillovers from New Zealand (local) and US (foreign) EPU on aggregate (NZSE) and sectoral indices of New Zealand stock market. The multivariate VAR (1)-BEKK-GARCH model is employed for this purpose. Overall, the findings suggest that NZ equity sectors and NZSE receive much stronger and more pronounced spillover effects from US EPU compared to the local counterpart (NZ EPU). While the return spillovers from both EPUs are somewhat similar yet limited to just a few sectors, the volatility spillovers from US EPU on NZ sectors outstrip those from the NZ EPU. For volatility spillovers, the domestically oriented sectors are relatively more vulnerable to NZ EPU, while those having export/import concentration with the US are mainly susceptible to US EPU. These findings may be useful to investors seeking sectoral diversification opportunities across New Zealand and the US.

The essay contributes to the literature in the following ways. First, it introduces a weekly EPU index for New Zealand that was previously unavailable. Even though a monthly

EPU index for the country has already been created and used by Tsui, Balli, Tan, Lau, and Hasan (2017) and Balli, Uddin, Mudassar, and Yoon (2017), a weekly NZ EPU index has its own utility for academic explorations, especially for studies that rely on weekly data in order to avoid the noise involved in daily data. The essay thus contributes to the ongoing efforts aimed at developing EPU indices of individual countries (Gentzkow & Shapiro, 2010; Baker et al., 2016; Alexopoulos & Cohen, 2015). To the best of our knowledge, this research is not only the first to develop a weekly EPU index for New Zealand, but also the first to create a weekly EPU index for any country. The essay's second contribution is to the literature that examines EPU spillovers on stock markets (Pástor & Veronesi, 2012 & 2013; Antonakakis, Chatziantoniou & Filis, 2013; Brogaard & Detzel, 2015; Bijsterbosch & Guerin, 2013; Liu & Zhang, 2015; Ko & Lee, 2015). Unlike most of this literature, which considers the spillover effects of local and foreign EPU on the domestic stock market separately, this essay simultaneously looks at the spillover effects of both EPUs on the stock market of a country. Furthermore, the extant literature typically analyses EPU spillovers on the aggregate stock markets of some large economies of Europe or those of a few emerging economies. However, it remains unclear whether the nature of such spillover effects for different equity sectors of a small open economy. Considering New Zealand as the sample country, this essay provides evidence of EPU spillovers for the equity sectors of a small open economy and thereby contributes to the literature.

Within the literature that explores the EPU-equity sector nexus, the current research is linked closely to Yu et al. (2018) and Yu et al. (2017). While these studies, respectively, analyze the effects of EPU on the return-volatility and long-run betas of various sectors, both studies take the US stock market as their backdrop. Also, both analyses are limited to 10 US sectors and US EPU only and explore the sector performance under policy uncertainty for a large economy. In their examinations, the authors relied on the GARCH-MIDAS framework (Engle, Ghysels & Sohn, 2013) and the DCC-MIDAS framework (Colacito, Engle, & Ghysels, 2011), respectively. This essay builds on their investigations by exploring the return and volatility spillovers directed from NZ EPU (US EPU) to 15 NZ equity sectors and NZSE. This essay thus provides a sharp contrast between how the equity sectors of two very different economies respond to policy uncertainty; clearly, New Zealand is a small open economy, and the US is a much larger economy.

Finally, by considering NZ equity sectors, the third essay makes a specific contribution to the literature that links US EPU with asset markets of small open economies. As mentioned above, two earlier investigations have been conducted on New Zealand's stock market from this perspective; they include the works by Kamber et al. (2016) and Stockammar and Österholm (2016). While both studies provide the basis for this analysis by setting the potential course of spillover effects from the US to small open economies (one of which is New Zealand), the focus of their analyses remained on how macroeconomic and financial variables, such as GDP and stock market index, in those economies responded to US EPU. Even when evaluating the stock market reaction to US EPU, both studies relied solely on the aggregate stock market index of New Zealand, with paying little attention to the sensitivity of stock market sectors. Moreover, the effect of local EPU on the performance of the aggregate stock market was entirely ignored by the two reports. By analyzing the New Zealand's stock market-EPU nexus, this essay captures the sensitivity of NZ equity sectors to international (US) EPU and local EPU (NZ). It thus fills the gaps left by the two studies. In other words, unlike the two studies, this essay not only considers the spillover effects of local EPU along with US EPU but also examines these effects at the disaggregated level of the New Zealand stock market, moving further down to the NZ equity sectors.

Upon considering New Zealand's economic ties with the United States, the results appear to be quite intuitive. The US is not only one of New Zealand's largest trading partners, but it is also the second-highest contributor of foreign direct investment (FDI) to the country after Australia. It seems that the presence of strong economic linkages with the US makes equity investors more concerned about EPU around the US economy than they are about New Zealand. This might be why the three sector-groups, namely Production and Industry, TMT (Technology, Media, and Telecom sectors), and Financials, are predominantly vulnerable to US EPU. The fact that the Financials group is most affected could be an indication of the fact that nearly one-third of New Zealand's inbound FDI goes to the financial sector.

The findings of this essay carry significant implications for equity investors, particularly for those institutional investors aiming to exploit diversification opportunities by simultaneously investing in the financial sectors (and aggregate market indices) of both countries. The finding that the US stock market responds strongly to the movements around US EPU shocks (Baker et al., 2016, Pástor & Veronesi, 2012 & 2013) may be considering while sorting the investment vehicles that are associated with the aggregate stock market. Because the present essay also noted that New Zealand's aggregate equity market is highly vulnerable to US EPU, any potential for diversification between the two stock markets may be restricted. Therefore, institutional investors taking simultaneous portfolio positions in both the stock markets should be cautious. The investors should also be watchful while making investments in the financial sectors of both countries, as Yu et al. (2017) found out that US EPU significantly drives the market risk of the US financial sector. Lucrative diversification opportunities may, however, exist across less competitive sectors of the New Zealand stock market, such as Retail, Travel-and-Leisure, and Technology sectors, due to their resilience against both local and US EPU.

5.2 Avenues for future research

First essay

An obvious limitation of the first essay is that it relies on GPU data of 18 Emerging Economies and the US only. Since Caldara and Iacoviello (2018) have developed the GPU indices only for these 19 countries so far, the first essay ought to be limited to these countries only. This investigation presented in the first essay may well be broadened to a global level by including more countries should the GPU indices for a wide range of countries had been available. Secondly, although the essay tried to estimate GPU transmission, these estimations are primarily cross-sectional, static, based on news information, and limited to a set of emerging economies and the US. Several questions remain and demand further investigations. For instance, future research may be aimed at investigating the dynamics of GPU transmission in terms of speed, volume, or even time. Researchers may examine the time-varying behavior of pairwise and total GPU transmissions. This may be achieved by applying the time-varying spillover models of Diebold and Yilmaz (2012) and Barunik and Krehlik (2018). Moreover, this research has strictly relied on the gravity model framework and the factors specific to that framework. There is, however, an exhaustive list of factors and approaches that may be utilized to explain this phenomenon more deeply than this research did.

This essay neither identifies any transmission mediums such as the internet, phone calls, television, or radio that usually facilitate the transmission of GPU nor it points out the types of geopolitical conflicts from where GPU could emanate. Future research may be conducted to identify the role of transmission mediums in GPU transmission. This question may be answered by extending the investigation of Weidmann (2015), which linked conflict spread to transnational phone calls. Similarly, the question regarding types of geopolitical conflicts may be answered by creating news-based indices that can capture the GPU of individual conflicts, and then by using these narrow indices along with the approach used in this study.

Second essay

The second essay examines how uncertainty spills over from US uncertainties to international stock markets. The essay strictly relies on three news-based uncertainty indicators of the US, namely EPU, EMU, and EMV, in order to compute the uncertainty spillovers. While results are quite informative, they are limited to uncertainty driven from economic policies, equity market, and equity market volatility. There are many other indicators of uncertainty that may be considered for future research on this topic. Even policy uncertainty has been split into several sub-policy categories, and several indicators of category policy-uncertainty have been developed recently and are made available on the EPU website. For instance, future research may extend the investigation proposed by this essay to consider news-based uncertainty indicators associated with monetary policy, fiscal policy, healthcare policy, national security policy, trade policy, and financial regulation policy. In particular, the spillovers from trade-related uncertainty in the US to the stock markets of the US's major trading partners might be interesting to study.

Third essay

The third essay has examined the spillover effects from local and foreign EPUs on the equity sectors of New Zealand - a small open economy. Future research may consider expanding to include other small open economies. Following Stockammar and Österholm (2016), for example, a sample of small open economies such as Australia, Canada, Denmark, Finland, Sweden, Iceland, and Mexico may be considered for this purpose. Based on our findings and considering the small-open nature of these economies, the countries having stronger (weaker) economic linkages with the US would be expected to experience stronger (weaker) spillovers from the US EPU as compared to the local EPU.

Another potential avenue for future research could be to investigate the impact of local and foreign EPUs on individual stocks listed on the New Zealand stock market. In this vein, the EPU spillovers on corporate investments may be explored by following Wu, Zhang, Zhang, & Zou (2020), or it may even be interesting to see whether local and foreign EPUs are priced in the cross-section of New Zealand stocks – this may be achieved by following Bali, Brown, & Tang (2017).

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Further readings:

Global Risk Report, World Economic Forum, 2018.

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International Monetary Fund, Foreign Financial Stability Report, April 2012.

International Monetary Fund, World Economic Outlook, September 2011.

Figure 5-1 Statement of contribution to doctorate with publications (Chapter 4)

DRC 16

MASSEY UNIVERSITY
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Mudassar Hasan
Name/title of Primary Supervisor:	Dr. Faruk Balli
Name of Research Output and full reference:	
Balli, F., Balli, H. O., Hasan, M., & Gregory-Allen, R. (2020). Economic policy uncertainty spillover effects on sectoral equity returns of New Zealand. Journal of Economics and Finance, 1-17.	
In which Chapter is the Manuscript /Published work:	Chapter 4
Please indicate:	
• The percentage of the manuscript/Published Work that was contributed by the candidate:	
and	
• Describe the contribution that the candidate has made to the Manuscript/Published Work:	
Mudassar Hasan is the main author of the paper, and while his supervisors have also made contributions reflected in their co-authorship, the paper is essentially the work of Mudassar.	
For manuscripts intended for publication please indicate target journal:	
Candidate's Signature:	Mudassar Hasan Digitally signed by Mudassar Hasan DN: cn=Mudassar Hasan, o=Massey University, ou=School of Economics and Finance, email=m.hasan1@massey.ac.nz, c=NZ Date: 2020.06.23 18:27:09 +12'00'
Date:	23/06/2020
Primary Supervisor's Signature:	Faruk Balli Digitally signed by Faruk Balli Date: 2020.06.23 21:55:02 +12'00'
Date:	23/6/2020

(This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis)

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