Uncertainty and Economic Activity: Does it Matter for Thailand?*

Tosapol Apaitan Pongsak Luangaram Pym Manopimoke[†]

Preliminary Draft: PLEASE DO NOT CITE

Abstract

This paper investigates the role of uncertainty for macroeconomic dynamics in Thailand. We compare five uncertainty proxies which captures uncertainty along various dimensions including economic policy, macroeconomic, and financial uncertainty. We find that while all uncertainty measures display countercyclical behavior, they deliver varying impacts on real GDP and its components. Based on a structural vector autoregression analysis, we find that the response of real activity to Thai economic policy uncertainty shocks are muted. On the other hand, the magnitude of real activity decline in response to macroeconomic and financial uncertainty shocks are as large as 1-1.5 percent, with most of the transmission occurring through investment and trade flows rather than consumption demand. Furthermore, we find that while the effect of macroeconomic uncertainty fluctuations are sudden upon impact, financial uncertainty shocks are more gradual and persistent. We also observe asymmetry in the effects of downside versus upside economic uncertainty shocks on real activity, but there appears to be no difference between uncertainty of short versus long horizons. Finally, foreign economic policy, macroeconomic and financial uncertainty shocks matters for the Thai economy, and we document a significant degree of spillover of financial uncertainty shocks from abroad.

Keywords: uncertainty, business cycles, spillovers.

JEL Classifications: D81, E32, F42

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*We would like to thank Patcharaporn Leepipatpiboon for excellent research assistance. The views expressed in this paper are of the authors and do not necessarily reflect those of the Bank of Thailand.

†Apaitan: Section Head of Real Economy, Puey Ungphakorn Institute for Economic Research, Bank of Thailand, E-mail: TosapolA@bot.or.th; Luangaram: Assistant Professor, Department of Economics, Chulalongkorn University, E-mail: pluangaram@gmail.com; Manopimoke: Principal Research Economist, Puey Ungphakorn Institute for Economic Research, Bank of Thailand, E-mail: PymM@bot.or.th.

1 Introduction

During recent years, macroeconomic and financial uncertainty and their effects on the economy has become a prominent issue. In the US and Euro Area countries, heightened levels of uncertainty has been frequently cited as a key reason for the weak recovery from the global financial crisis (GFC) and persistently high unemployment rates (FOMC, 2009; Balta et al., 2013). At the same time, concerns regarding the spillover impact of economic and policy uncertainty in advanced countries on emerging market economies have been featured strongly in international policy debates. A number of studies show that with rapid globalization in trade and financial markets, policy shocks originating in one country can enhance the degree of uncertainty in another country, ultimately affecting its business cycle (Colombo, 2013; IMF, 2013; Berger et al. 2016).

Measuring, monitoring and analyzing the impact of uncertainty is crucial for various reasons. From a policy perspective, being able to quantify the macroeconomic effects of uncertainty as well as recognize their sources is crucial towards formulating the appropriate policy response. Uncertainty that spillovers from abroad, or occurs exogenously from geopolitical turmoil or natural disasters may affect individual sectors of the economy differently and have different degrees of persistence from uncertainty that arises as an endogenous response to other macroeconomic forces such as certain types of demand and supply shocks. In addition, the prevailing degree of uncertainty in an economy may affect the effectiveness of economic policies. Monetary policy stimulation packages or implementations of fiscal measures or structural reforms during states of high uncertainty might require more work to achieve desired outcomes.

Against this backdrop, we seek to understand the dynamic effects of uncertainty on the real economy in Thailand. In doing so, we aim to make three key contributions to the literature. First, measuring uncertainty is a challenging task since it is not directly observable, and to date, there is no objective measure of uncertainty for Thailand. Therefore, we propose and evaluate five uncertainty indicators for the Thai economy based on a range of well known methods employed in the literature. These measures span from economic policy uncertainty derived from newspaper article counts as proposed by Baker et al. (2016), indicators of macroeconomic and financial uncertainty based on the unforecastable components of a broad set of economic variables as in Jurardo et al. (2015) and Rossi and Sekposyan (2015), and an aggregate proxy for uncertainty based on the first principal component extracted from a swathe of uncertainty indicators such as sentiment indices and implied and historical volatilities of currency and financial markets.

Our second contribution is analyzing the dynamic impact of these five uncertainty measures on real GDP, consumption, investment and exports in Thailand based on a structural vector autoregressive model (SVAR). We focus on examining the behavior of uncertainty on real activity along a number of dimensions, such as distinguishing between the effects of short versus long run uncertainty, asymmetries that might exist between upside and downside uncertainty, as well as drawing a distinction between shocks that are short-lived versus those that are more persistent. Finally, given that Thailand is a small open economy that has been highly influenced by external shocks, we extend the SVAR framework to include US and global-based uncertainty shocks. Doing so provides additional insights as to how foreign uncertainty shocks may spillover to a small open economy such as Thailand.

As a preview of the main empirical results, we find that first, all uncertainty measures are countercyclical with respect to real economic activity, but there are marked differences in the properties of the various uncertainty measures. For example, news-based economic policy measures are in general more volatile and captures more heightened uncertainty episodes than others. Second, based on the SVAR analysis, macroeconomic uncertainty generates sharp and sudden impacts on the real economy while financial uncertainty shocks are more persistent and affect the economy more gradually. News-based economic policy uncertainty proxies on the other hand show little to no relation with the Thai economy. Third, with the exception of news-based shocks, the peak decline in RGDP following a Thai uncertainty shock is approximately 1 percent, with most of this decline being driven by the strong contraction in investment and exports. Fourth, while real activity responds to short versus long run uncertainty in the same way, its response is asymmetric in downside versus upside uncertainty shocks. Finally, US-based and global uncertainty shocks have a significant bearing on the Thai economy, causing a contraction in investment and export on the scale of 1-2 percent. Among the different types of uncertainty, there are large spillovers of financial uncertainty shocks from abroad to Thai domestic uncertainty measures, yet little overlap for macroeconomic and economic policy uncertainty.

Our empirical findings joins a growing literature that examines the effect of uncertainty on real economic activity for individual countries (Bloom, 2009; Jurardo et al., 2015; Meinen and Roehe, 2017), as well as the strand of literature that examines the international transmission of global uncertainty shocks (Colombo, 2013; Luk et al.,2017; Mumtaz and Theodoridis, 2017). Much of this existing evidence on the dynamic effects of uncertainty exist only for developed economies where, even there, important differences across countries have been observed. We add to this literature evidence from Thailand, which to our knowledge is the first analysis of uncertainty dynamics for a small, emerging, open-economy in Asia.

The remainder of our paper is organized as follows. Section 2 provides an overview of uncertainty concepts in the literature and how they are applied to construct uncertainty proxies for Thailand. Section 3 discusses the overall properties and provides an extensive comparison between the different uncertainty indicators. Section 4 outlines the empirical model and discusses the findings on how uncertainty matters for real economic activity. Section 5 concludes.

2 Measuring Uncertainty

Uncertainty is inherently unobservable, thus its measurement is a challenging task. While true economic uncertainty is difficult to quantify since it relates to individuals' subjective beliefs about the economy, there are a number of studies that propose methods to measure uncertainty based on a wide range of proxies. The earlier measures are mostly financial-based, made popular by the influential work of Bloom (2009) whom advocated the use of implied and realized stock market volatilities. The cross-sectional dispersion of survey-based forecasts (Bachmann et al., 2013) is another commonly used proxy for uncertainty. However, the use of stock market volatility has been criticized on the grounds that it can be quite volatile due to changes that are unrelated to uncertainty such as if leverage changes or if there are movements in sentiment or risk aversion of investors. Regarding forecaster disagreement, it has been pointed out that it could be measuring a divergence or disagreement of opinions among forecasters rather than the underlying uncertainty about the economy. In addition, survey respondents may confuse first moment shocks, which may correspond to for example, a deterioration in the level of growth, with second moment ones, that properly represent a widening in uncertainty around the mean growth path.

In this paper, we construct several uncertainty proxies for Thailand based on more recently proposed measures of uncertainty in the literature. The first is policy uncertainty by Baker et al. (2016), measured as the frequency count of newspaper articles with the appearance of 'uncertainty-related' keywords. Unlike finance-based measure that focuses only on the stock market, the news-based measures has the advantage of being able to capture uncertainty along various dimensions, such as those related to economic policy. Second, we estimate macroeconomic and financial uncertainty measures based on the diffusion index and stochastic volatility models of Jurado et al. (2015) and Ludvigson et al. (2018), which measures aggregate uncertainty as the common variability in the purely unforecastable component of the future value of a large number of economic variables. One advantage of this model-based measure is that it is able to produce uncertainty measures for various future forecasting horizons, enabling us to separate between short and long term uncertainty. Also, it constructs uncertainty by utilizing information from a large dataset, which ensures that the final measure of aggregate uncertainty is one that is commonly shared across many sectors, markets and geographical regions.

Third, we consider the uncertainty index of Rossi and Sekhposyan (2015), which proposes an index based on the realized and historical distribution of forecast errors obtained from surveys of professional forecasters. One key advantage of this approach is that it allows uncertainty shocks to be asymmetric, that is, they distinguish between upside and downside uncertainty which may affect real activity in different ways. Finally, we extract the first principal component of the aforementioned uncertainty measures and additional uncertainty proxies to obtain an overall uncertainty estimate for Thailand. We combine financial and survey-based measures for these additional proxies, which include sentiment indices at the consumer and firm level, together with the realized and implied volatilities in currency and stock markets. Details on how we construct these uncertainty measures for Thailand are described in more detail below.

2.1 Economic Policy Uncertainty

Baker et al. (2016) (BBD hereafter) propose a novel approach to compute US economic policy uncertainty (EPU) based on a frequency count of news stories that are related to uncertainty about the economy or macroeconomic policy. The index is based on the frequency of articles in leading US newspapers that contain the key terms "economic" or "economy"; "uncertain" or "uncertainty" and selected policy terms such as "congress", "deficit", and the "Federal Reserve". To deal with the issue that the overall volume of articles varies across newspapers and time, the raw counts are scaled by the total number of articles in the same newspaper and month, then standardized and averaged across all newspapers before normalizing the series to a mean of 100 over the sample period. Based on a similar approach, the authors also develop EPU indices for various other major economies in which they used to construct a global economic policy uncertainty index[1]. Many of these indices are for European countries, but EPU indices for Asian countries also exist including those for China, Japan, Australia and Hong Kong (see Baker et al., 2013; Arbatli et al., 2017; Moore, 2017; Luk et al., 2017).

Following the approach of BBD, we construct a news-based uncertainty measure

[1] These measures can be found at http://www.policyuncertainty.com.

for Thailand. Since we choose to focus only on monetary and fiscal policy uncertainty, we follow the criteria listed below in specifying keywords for the search:

- {("Thailand" or "Thai") and economy} AND
- {"uncertain" or "uncertainty" or "uncertainties" or "risk"} AND
- {"bank of thailand" or "central bank" or "monetary policy" or "baht" or "currency" or "exchange rate" or "capital flow" or "ministry of finance" or "finance ministry" or "budget" or "tax" or "government spending" or "public debt" or "budget"}.

For the data source, we rely on archives from Bloomberg and the Bangkok Post, which are the two English news media outlets for Thailand that have a long enough time span and can provide sufficient coverage in terms of content. Our final product is a monthly news-based uncertainty index that spans 2000M1-2018M12, in which we take the within-quarter averages to arrive at a quarterly index. Hereafter, the index will be referred to as the Thai economic policy uncertainty index (TEPU).

2.2 Aggregate Macroeconomic and Financial Uncertainties

Jurardo et al. (2015) (JLN hereafter) propose a methodology to measure aggregate uncertainty for the US as the conditional variance of the unforecastable component common to a large number of macroeconomic and financial variables. Their measure is based on the premise that what matter for agents' decisions is not whether particular economic indicators have become more or less variable or disperse, but whether the economy has become more or less predictable. In this way, their measure of uncertainty is different from existing approaches since it is defined as a deterioration in predictability rather than just volatility. Also, in contrast to previous measures that uncertainty is often based on a single (or a few) economic indicators, JLN's measure of uncertainty is defined as common to a large set of economic time series that spans many markets and segments.

Based on the JLN approach, several studies construct measures of aggregate uncertainty for countries in the Euro area (see Redl, 2017; Meinen and Roehe, 2017). Here, we apply the JLN methodology to construct aggregate measures of uncertainty for Thailand. We construct two types of aggregate uncertainty measures - macroeconomic and financial. While readers should refer to JLN for full details of the econometric approach, the authors' methodology is briefly summarized here for ease of reference.

First, let y_{jt}^C be a variable in either the macro or financial category. Its forecast, $E[y_{jt+h}^C|I_t]$ can be estimated from the following factor augmented forecasting model:

$$y_{jt+1}^C = \phi_j^y(L)y_{jt} + \gamma_j^F(L)\hat{\mathbf{F}}_\mathbf{t} + \gamma_j^W(L)\mathbf{W_t} + v_{jt+1}^y \tag{1}$$

where $\phi_j^y(L), \gamma_j^F(L), \gamma_j^W(L)$ are finite-order polynomials. The factors $\hat{\mathbf{F}}_\mathbf{t}$ are drawn from the information set I_t which is approximated by the full data set which contains both macro and financial time series variables[2]. $\mathbf{W_t}$ contains additional predictors that are meant to capture possible nonlinearities such as the squares of the first component of $\hat{\mathbf{F}}_\mathbf{t}$. In the model, the prediction error for $y_{jt+1}^C, \hat{\mathbf{F}}_\mathbf{t}, \mathbf{W_t}$ are permitted to have time-varying volatility $\sigma_{jt+1}^y, \sigma_{kt+1}^F, \sigma_{lt+1}^W$ respectively, which generates time-varying uncertainty in the overall series y_{jt}^C.

From Eq (1), we compute the forecastable component $E[y_{jt+h}^C|I_t]$ which form the basis of our uncertainty measures. More specifically, we calculate the forecast error as $V_{jt+h}^{y^C} = y_{t+h}^C - E[y_{jt+h}^C|I_t]$, where the conditional volatility of this forecast error $E[(V_{jt+h}^{y^C})^2|I_t]$ is then generated based on a parametric stochastic volatility model for the one-step-ahead prediction errors in y_{jt}^C and the factors. Then, using a recursive method, we can estimate $E[(V_{jt+h}^{y^C})^2|I_t]$ for future horizons $h > 1$. As discussed in JLN, the stochastic volatility modelling approach allows for shocks to the second moment of a variable to be independent of the first moment, consistent with theoretical models of uncertainty which presumes the existence of an uncertainty shock that independently affects y_j.

Finally, uncertainty about the variable y_{jt}^C at horizon h can be computed as:

$$U_{jt}^{y^C}(h) \equiv \sqrt{E[(V_{jt+h}^{y^C})^2|I_t]} \tag{2}$$

which measures uncertainty as the conditional volatility of the purely unforecastable component of the h-step-ahead realization of each underlying macroeconomic and financial time series based on available information at time t. We follow JLN and assume equal weights $w_j = \frac{1}{N_C}$ to arrive at the aggregate uncertainty measure[3]:

[2]To provide a guide for factor estimation, we use the Bai and Ng (2002) information criterion (IC) to select the number of factors. The IC suggests 3 factors which explains only 21 percent of the variation in the dataset, where the first three factors loads heavily on real activity measures such as retail sales and the manufacturing production index, the SET index and return on its components, and government bond rates respectively. Since the variation explained by the three factors are rather low we also consider extracting 18 factors which can explain at least half of the variation of series in the dataset. However, we find that whether using 3 or 18 factors provides aggregate uncertainty measures that are not statistically significantly different, thus we use 3 factors in our empirical investigation.

[3]Other weighting schemes are also possible such as by employing the principal component analysis (PCA) approach. We follow JLN and construct these measures as part of our robustness checks, but we find that the various approaches produce final indices that do not differ significantly.

$$U_t^{y^C}(h) \equiv plim_{N \to \infty} w_j U_{jt}^{y^C}(h). \tag{3}$$

Based on Eq (3), we compute the macroeconomic and financial uncertainty measures by aggregating the conditional variances of the unforecastable components over variables that either belong to the macroeconomic or financial categories. For both measures, we compute uncertainty for the forecasting horizons $h = 1, 4$, and 8 quarters, where we henceforth refer to these indices as $M1, M4, M8, F1, F4$, and $F8$ respectively. In terms of the dataset used to construct these indices, we use quarterly macroeconomic and financial data obtained from the Bank of Thailand and the Stock Exchange of Thailand databases over the 2002Q1-2018Q4 sample. Readers are referred to Appendix A for details on the full dataset that we employ, their transformations to ensure stationarity, as well as the groupings that we use to classify between macroeconomic versus financial based variables.

2.3 Bank of Thailand's Economic Uncertainty

The Bank of Thailand (BOT) gives an explicit account of its uncertainty estimate around the economic outlook for main macroeconomic variables such as GDP and inflation by publishing its forecasts in the form of a fan chart and and a table revealing the probability density of forecasts (pdf) in quarterly Monetary Policy Reports. Table 1 shows an example of GDP growth projections from the September 2017 forecast round, where each row represents the probability that the realized outcome will fall within a given range.

Figure 1: Probability Distribution of the Bank of Thailand's GDP Growth Forecasts

Table: Probability distribution of GDP growth forecast

Percent	2017		2018				2019	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
10-12	0	0	0	0	0	0	1	1
8-10	0	0	1	2	2	3	4	5
6-8	2	9	10	10	12	12	13	13
4-6	37	39	32	27	26	25	24	23
2-4	51	38	35	31	29	28	26	25
0-2	9	12	18	20	19	20	19	18
(-2)-0	0	1	4	8	8	9	10	10
< (-2)	0	0	1	2	3	4	4	5

Source: Band of Thailand 2017Q3 Monetary Policy Report.

We translate this fan chart into a series of BOT uncertainty measures for the Thai economy. In doing so, we first uncover the underlying forecast distribution from the fan chart according to a method outlined in Appendix B, then apply the method of Rossi and Sekhposyan (2015) (hereafter RS)[4]. According to the RS approach, macroeconomic uncertainty is quantified by comparing the realized forecast error to the percentile in the historical distribution of forecast errors. If the realized forecast error fall in the tails of the ex-ante forecast error distribution, it represents a macroeconomic environment that is very uncertain. Note that since the RS approach considers the entire distribution of forecast errors in constructing the uncertainty index, similar to JLN, it is able to properly separate out the 'second moment' of the forecast error distribution from the mean or the 'first moment'.

Based on the underlying pdf of forecasts, the cumulative density of realized forecast errors can be calculated as:

$$U_{t+h} = \int_{-\infty}^{e_t+h} p(e)de \tag{4}$$

where $e_{t+h} = y_{t+h} - E_t(y_{t+h})$ denotes the actual realized forecast error of output for the $h-$step-ahead horizon and $p(e)$ is the pdf which could either be defined as the unconditional density of the whole sample (ex-post) or the density of the real-time data (e.g. the data up to forecasting period). Note that by construction, U_{t+h} will fall between zero and one, where a value closer to one denotes positive 'shock' since the difference between the realized and expected value or the mode of the forecast distribution is large (eg. higher GDP than expected). By similar logic, a value closer to zero represents a negative 'shock' (eg. lower GDP than expected). These upside and downside uncertainty measures can be expressed formally as:

$$U^+_{t+h} = \frac{1}{2} + max\{U_{t+h} - \frac{1}{2}, 0\} \tag{5}$$

$$U^-_{t+h} = \frac{1}{2} + max\{U_{t+h} - \frac{1}{2}, 0\} \tag{6}$$

where by construction, these measures will always be between one-half and one. Finally, the overall index can be written as:

$$U^*_{t+h} = \frac{1}{2} + |U_{t+h} - \frac{1}{2}|. \tag{7}$$

For the case of Thailand, we construct the BOT's positive and negative economic uncertainty measures according to Eqs. (5) and (6) for the $h = 1, 4, 8$ forecasting horizons (henceforth referred to as BOT^+1, BOT^+4, BOT^+8 and $BOT^-1, BOT^-4,$

[4]The original index of RS is based on the the Survey of Professional Forecasters' (SPF) forecasts of Real Gross Domestic Product (RGDP) for the US. However, SPF data for RGDP in Thailand only covers a short sample range which is insufficient to build a reliable pdf. Therefore, we rely on the distribution of forecast errors as implied by the BOT's fan chart for RGDP that is published in the BOT's Monetary Policy Report instead.

$BOT^{-}8$ respectively) as well as an overall measure according to Eq. (7) (henceforth referred to as $BOT^{*}1, BOT^{*}4, BOT^{*}8$ respectively). Due to limitations in data from BOT fan charts, the BOT uncertainty series span 2002Q2-2017Q3.

2.4 Principal Component Uncertainty

Although there is some variation among the different proxies for uncertainty, past studies show that uncertainty measures tend to move together, suggesting that there is a common component across all measures. Therefore, another popular proxy for uncertainty is to extract the first principal component (PC) from a swathe of uncertainty measures (see Haddow et al., 2013; Forbes, 2016; Redl, 2017). This approach has the advantage of being able to capture uncertainty along a number of various dimensions.

To construct a PC-based measure for Thailand, we extract the first principal component from seven different measures. The first proxy captures the uncertainty outlook of households as measured by the Thai consumer confidence index (CCI). The second reflects uncertainty viewed by firms, measured by the Thai business sentiment index (BSI). Next are uncertainty proxies pertaining to macroeconomic and financial markets as a whole, captured by JLN-based macroeconomic and financial uncertainty indices (we use the one-quarter ahead indices, $M1$ and $F1$). Fifth and sixth are uncertainties in stock and currency markets, proxied by the 60 day moving-average of the Stock Exchange of Thailand (SET50) historical volatility index (SETVOL) and the 3-month moving-average of the US dollar to Thai baht exchange rate option implied volatility (USDTHBVOL)[5]. The final measure captures economic policy uncertainty, proxied by the number of press articles citing monetary and fiscal policy uncertainty. This measure is the news-based uncertainty index (TEPU). Note that the reason why we do not include BOT uncertainty measures in the PC-based proxy is because unlike other measures, BOT indices are bound between 0.5 and 1.

[5]Following the influential study of Bloom (2009), many studies proxy forward-looking uncertainty with implied volatility of stock returns and exchange rates. The premise of proxying uncertainty with option-implied volatility of equity prices is that it reflect investors' subjective uncertainty about the future outlook of the stock market, as higher uncertainty drives up demand and hence prices for option contracts. Similarly, option-implied volatility of the exchange rate can provide a guide of companies' uncertainty about export receipts or the costs of imported inputs. Unfortunately, option-implied volatility of equity prices do not exist for Thailand so we use a moving-average of the historical volatility of the SET50 instead.

3 Uncertainty Estimates for Thailand

In this section, we assess the overall properties of our constructed uncertainty measures for Thailand. First, we examine the news-based policy uncertainty index for Thailand (TEPU), plotted in Figure 2, with the dashed horizontal line corresponding to 1.65 standard deviations above the mean. As shown, uncertainty in Thailand according to this measure increased sharply in 2006 and remained relatively high until 2011. As shown, there are 4 heightened episodes which exceeded the 1.65 standard deviation mark. They correspond to the following events:

- 2006: A period of political turmoil, leading to a military coup in September. Due to persistent capital inflows at the time, the Thai baht also rapidly appreciated, putting pressure on the BOT's ability to maintain macroeconomic stability conducive to long-term sustainable economic growth. During this time, the BOT adopted a series of policy measures in order to reduce pressure on the exchange rate, including unremunerated reserve requirement implemented in December.

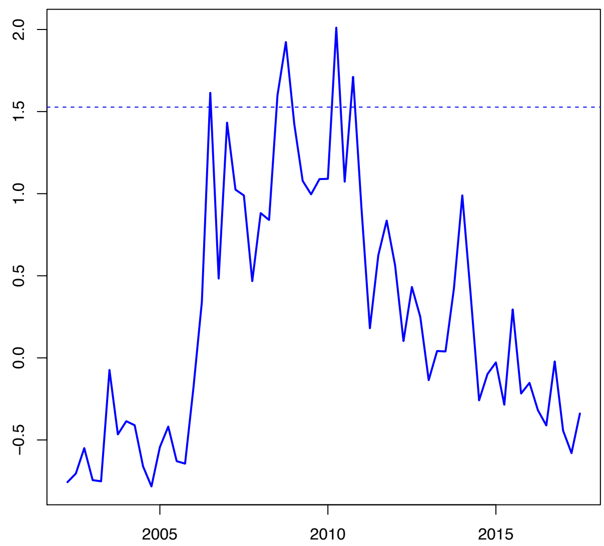
- 2008: A severe contraction in real economic activity and heightened policy uncertainty due to the GFC.

- 2010: A period of domestic political conflict stemming from a series of protests organized by the National United Front of Democracy Against Dictatorship (UDD) (also known as the "Red Shirts"), calling for Prime Minister Abhisit Vejjajiva to dissolve the parliament. During this time, there was an influx of capital flows which led the Thai baht to rise sharply, causing some public debates between the government and the BOT regarding the direction of monetary policy setting.

- 2011: Thailand encountered the worse floods in 70 years. These severe floods led to a partial halt in some production sectors and affected economic activities indirectly through supply chain disruptions. This reinforced the negative impact on exports from the global economic slowdown, further undermining private sector confidence. During this time, the government's policy unclear water management strategy were among the factors that enhanced policy uncertainty levels in Thailand.

Next, Figures 3a and 3b plots aggregate macroeconomic and financial uncertainty measures for Thailand at three forecasting horizons: $h = 1, 4$, and 8 quarters, with matching dashed horizontal lines that correspond to 1.65 standard deviations above the mean for each series. Compared to the TEPU measure, the

Figure 2: News-based Economic Policy Uncertainty for Thailand

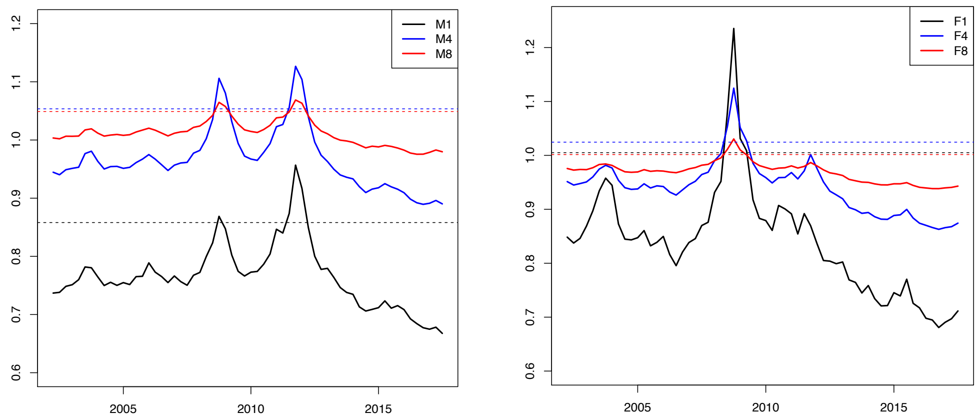


Note: Dashed horizontal line shows 1.65 standard deviations above the mean of the TEPU series.

aggregate uncertainty measures are less volatile, and contain less heightened uncertainty episodes. This finding is in line with those of JLN, whom find that their measures of uncertainty for the US contain less variation and imply far fewer large uncertainty episodes than what is inferred from all commonly used proxies. They argue that this is because compared to existing measures, their measures are broad-based and not influenced by the variation of any one single series that may be driven by events unrelated to uncertainty.

The two aggregate uncertainty measures display some slight differences. The financial index appears slightly more volatile, especially at the $h = 1$ horizon, which is not surprising given that financial variables generally exhibit more variability than macroeconomic ones. Examining the spikes in uncertainty that occur 1.65 standard deviations above the mean, all series capture economy-wide uncertainty that occurred during the GFC. In fact, the financial index displays only one major peak during this time, while the macroeconomic uncertainty measure displays a second, slightly more striking peak during the second half of 2011, corresponding to the Great Floods episode that has been previously discussed. Finally, in terms of the general properties of the series, we find that both macroeconomic and financial uncertainty measures increase with the forecasting horizon h except for at the peaks where most shorter horizons display higher levels of uncertainty due to steeper increases during heightened uncertainty episodes. Also, we observe that as the horizon increases, the variability of aggregate uncertainty generally declines.

Figure 3: Aggregate Uncertainty Measures for Thailand



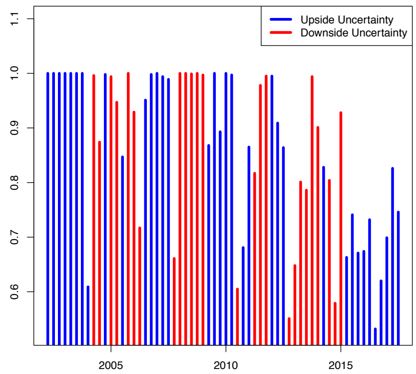
(a) Macroeconomic Uncertainty (b) Financial Uncertainty

Note: The left and right panels show JLN-based 1, 4 and 8 quarter-ahead macroeconomic and financial uncertainty series ($M1, M4, M8$ and $F1, F4, F8$ respectively). Dashed horizontal lines show 1.65 standard deviations above the mean of each corresponding uncertainty series.

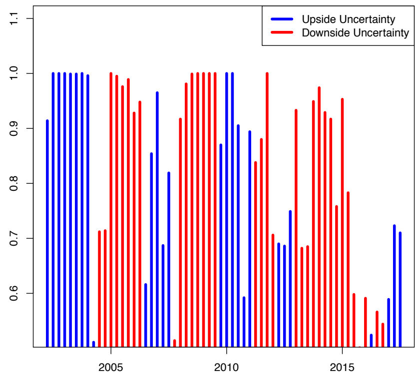
Next, we examine the economic uncertainty measures constructed based on applying the RS approach to the BOT's published fan charts for GDP growth forecasts. Figure 4 reports upside and downside uncertainty for the horizons h =1, 4, and 8 quarters. Examining upside uncertainty first, we find that upside uncertainty for the Thai economy according to the BOT's forecasts are slightly more pronounced at shorter horizons. Positive uncertainty that remained consistently strong across all forecasting horizons corresponded to the pre 2005 period, which was a time of strong economic stability, ample liquidity in financial markets and economic growth exceeding 5 percent.

As for downside uncertainty, we do not observe large differences across the three horizons. As shown in Figure 4, downside uncertainty occurred over three distinct time periods - in 2006, 2008, and 2013-2015. The 2006 episode overlaps with the first uncertainty spike captured by the TEPU measure. The 2008 episode is the GFC, which thus far has been an event captured by all uncertainty measures for Thailand. The 2013-2015 episode however, is a newly captured event, although when looking back at the TEPU measure in Figure 2, it does show some moderate increases during this time period as well. During this time, the Thai economy slowed down due to weak domestic demand, partly owing to expired government stimulus measures. At the same time, despite the recovery in global demand, Thailand experienced sluggish recovery in exports as the boost in foreign demand were concentrated in certain goods that were not on Thailand's list of main export products. During this time, the Monetary Policy Committee of the BOT carried out a series of policy cuts to stimulate the economy.

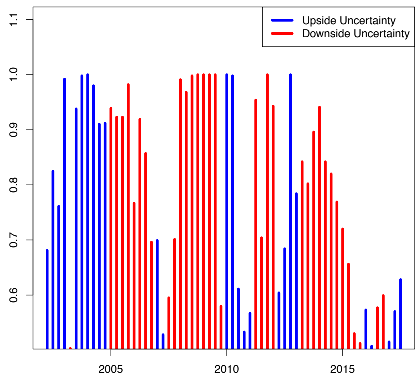
Figure 4: Upside and Downside BOT Economic Uncertainty for Thailand



(a) h=1



(b) h=4



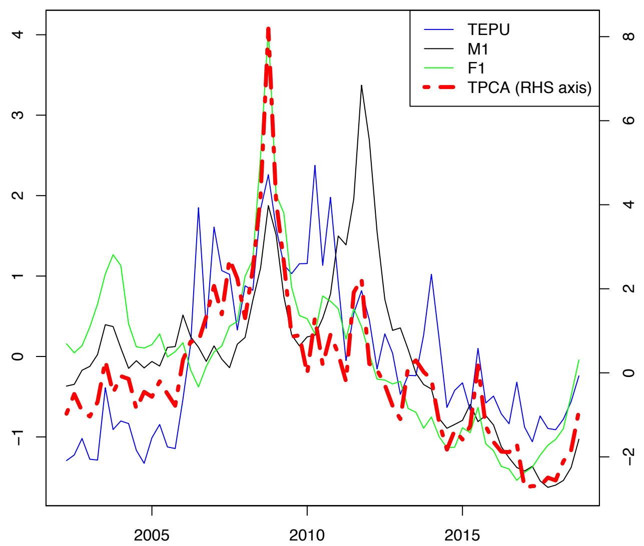
(c) h=8

Note: Plotted are upside and downside uncertainty measures extracted from BOT fan charts for GDP growth forecasts according the RS approach. Estimates are reported for h= 1, 4, 8 quarter-ahead forecasting horizons ($BOT^{+}1, BOT^{+}4, BOT^{+}8, BOT^{-}1, BOT^{-}4, BOT^{-}8$ respectively).

Finally, we plot the PC-based measure of economic uncertainty in Figure 5. We also show the $TEPU$, $M1$, and $F1$ components alongside for comparison purposes, and plot the remaining four components that also enter the PC-based measure in Figure 6. Upon first glance, the overall trajectory of the TPCA appears to move closely with $F1$. Furthermore, similar to $F1$ it only contains one distinct peak during the GFC. However, based on the correlation coefficients between the TPCA measure and its components as reported in Table 1, TPCA is strongly correlated with other proxies as well, with the exception of CCI, implying that similar to other countries, uncertainty measures for Thailand typically comove and have a strong 'common' component. From Table 1 we also find that the correlation of all uncertainty measures have the expected sign except for CCI. We suspect that this is because it is the only measure that did not undergo dramatic changes during the

GFC.

Figure 5: Principal Component of Uncertainty Measures for Thailand



Note: Plotted is the first principal component (TPCA) of seven uncertainty proxies: news-based economic policy uncertainty (TEPU), one-quarter-ahead macroeconomic uncertainty (M1), one-quarter-ahead financial uncertainty (F1), 60 days moving-average historical volatility of the SET50 index (SETVOL), 3-month moving average option implied volatility of the USDTHB exchange rate (USDTHBVOL), the consumer confidence index (CCI) and the business sentiment index (BSI).

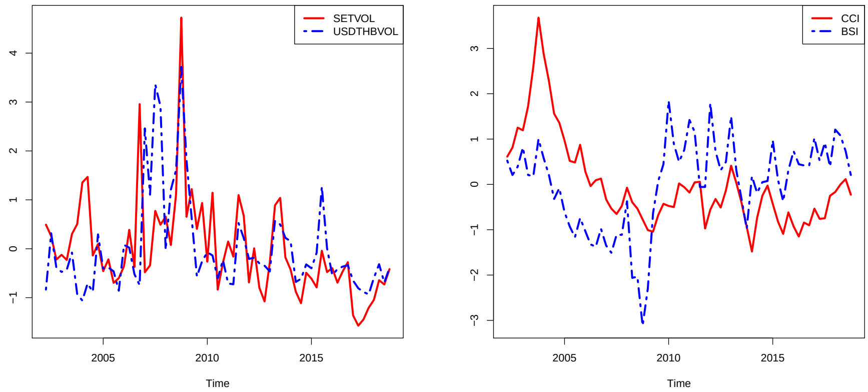
Table 1: Correlation Among Uncertainty Measures and RGDP Growth

Correlation	**M1**	**F1**	**TEPU**	**CCI**	**BSI**	**SETVOL**	**USDTHBVOL**	**PCA**	**RGDP**
M1	1								
F1	0.67	1							
TEPU	0.51	0.50	1						
CCI	0.04	0.26	-0.46	1					
BSI	-0.22	-0.47	-0.36	0.14	1				
SETVOL	0.47	0.70	0.41	0.13	-0.44	1			
USDTHBVOL	0.31	0.47	0.53	-0.32	-0.65	0.47	1		
PCA	0.69	0.84	0.75	-0.14	-0.69	0.77	0.77	1	
RGDP	-0.21	-0.13	-0.26	0.46	0.35	-0.20	-0.24	-0.32	1

Note: Reported are correlation coefficients between one-quarter-ahead macroeconomic uncertainty (M1), one-quarter-ahead financial uncertainty (F1), news-based economic policy uncertainty (TEPU), the consumer confidence index (CCI), the business sentiment index (BSI), the 60-day moving average of the SET50 historical volatility, the 3-month moving average option implied volatility of the USDTHB exchange rate (USDTHBVOL), the principal component based measure of uncertainty, and RGDP growth.

In sum, we have found that the various proxies for Thai uncertainty display strong comovements. JLN-based aggregate measures capture fewer uncertainty episodes than news-based ones, while financial market proxies including stock and currency market volatilities are volatile. These findings are more or less consistent

Figure 6: Market and Survey-based Uncertainty Proxies



(a) Stock and Currency Markets (b) Household and Firms

Note: The left panel plots the the 60-day moving average of the SET50 historical volatility and the 3-month moving average option implied volatility of the USDTHB exchange rate (USDTHBVOL). The right panel plots the Thai consumer confidence index (CCI) and the Thai business sentiment index (BSI).

with the literature. Finally, we examine the relationship between our uncertainty measures and the year-on-year RGDP growth rate. According to the last row of Table 1, all uncertainty measures are correlated with RGDP growth with the expected sign, providing evidence that the effects of uncertainty on real economic activity are countercyclical. In other words, uncertainty tends to be high during periods of RGDP growth declines and vice versa.

Finally, we examine the magnitudes of correlation between the uncertainty proxies and RGDP growth. Overall, they are slightly weak compared to JLN. For example, JLN report that the correlation between US macroeconomic uncertainty and US industrial production is as high as -0.6. However, note that their result are calculated over a much longer time span than ours, thus being able to capture a larger number of recessionary episodes. However, our results are not out of line when compared to other countries. For a sample of 32 countries, Cesa-Bianchi (2018) finds correlation coefficients between realized stock market volatility and real GDP growth to be within the range of -0.3 to -0.5. We examine the relationship between uncertainty and real economic activity in greater detail in the next section.

4 Uncertainty and Real Economic Activity

Dating back to at least Keynes (1937), it has been proposed that uncertainty generates reductions in real activity. Since then, there has been a voluminous literature on the various channels and relationships between the two (see Haddow et al. (2013) and Forbes (2016) for an overview). Among these, some emphasize on the demand side effects of uncertainty through investment and consumption. Under real options theory, heightened uncertainty can delay decisions of firms because factors such as adjustment costs make decisions costly to reverse (Bloom, 2009; Bernanke, 1983). In the face of high uncertainty, the value of this 'wait and see' option increases, and therefore can depress investment spending temporarily. As for households, heightened uncertainty may induce them to increase their precautionary savings to draw on during periods of temporarily low income if they are risk averse, leading to a reduction in consumption (Kimball, 1990; Carroll, 1997). Other studies emphasize on the supply side effects of uncertainty through credit provisions and productivity growth. When economic uncertainty is high, banks are reluctant to provide loans, credit conditions tighten, which ultimately lowers output (Gilchrist et al. 2014).

In this section, we focus on the demand side effects of uncertainty and evaluate whether uncertainty shocks matter for real activity variables in Thailand. If so, we ask how do their dynamic effects in terms of both impact and persistence differ among various measures of uncertainty? More specifically, we analyze how uncertainty shocks may affect real gross domestic product (RGDP) through its selected components - namely consumption (C), investment (I), and exports (X). Note that among these components, its effect on investment has received the most attention, and it is believed to be the most important channel by which uncertainty influences the business cycle due to its heavy reliance on opinions about future events. Since Thailand is a small open economy with heavy reliance on international trade, we believe that uncertainty could also have a large bearing on exports as well.

4.1 Data and Empirical Set Up

Past studies have found that empirically, uncertainty shocks have a negative and statistically significant impact on real activity such as GDP. The common approach to examine dynamic relationships between real activity and uncertainty proxies have been based on a structural vector autoregression (VAR) framework. We follow this approach and estimate two empirical VARs. First, we estimate a domestic VAR to examine the responses of RGDP, C, I, and X to the various innovations in Thai uncertainty proxies. Then, due to Thailand being a small open economy, we augment the domestic VAR with foreign uncertainty shocks to evaluate the relative importance of domestic versus foreign shocks in driving real economic activity in Thailand. Both VAR estimations rely on quarterly data spanning 2002Q2-2017Q3, where the span of the sample is limited by the shortest uncertainty series which is the BOT economic uncertainty measure.

The domestic VAR is based on the standard approach in the uncertainty literature which uncover orthogonal shocks by a Cholesky decomposition. For the recursive ordering of the VAR, we adopt a similar ordering to BBD: $\{U_t$, the log of the SET index, the policy rate, log of the consumer price index (CPI) and the log of the real activity measure$\}$[6]. U_t is the uncertainty index that is added one at a time to the VAR, and includes all proxies: $\{TEPU, M1, M4, M8, F1, F4, F8, BOT^{+}1, BOT^{+}4, BOT^{+}8, BOT^{-}1, BOT^{-}4, BOT^{-}8, BOT^{*}1, BOT^{*}4, BOT^{*}8, TPCA\}$. The real activity variables are the log of real GDP, C, I and X, also added one at a time to the VAR. With Thailand being a small open economy, we also control for international trade by including the log of world imports as an exogenous or control variable in the VAR specification. All data is obtained from the Bank of Thailand database, and the VAR includes a constant and one lag of all variables[7].

To augment the domestic VAR with foreign uncertainty shocks, we simply add three foreign uncertainty measures (U_t^*), one at a time, as the first variable in the domestic VAR. U_t^* includes the JLN's estimate for macroeconomic and financial uncertainty in the US at $h = 1$, (M_1^*, F_1^*), and the global news-based uncertainty measure constructed by BBD (GPU), where these measures can be downloaded from the respective authors' websites. Note that in these augmented VAR specifications, the Thai uncertainty measure that enter the VARs are the foreign measures' counterparts, ie. $\{M_1, F_1, TEPU\}$ for $\{M_1^*, F_1^*, GPU\}$ respectively. Similar to the domestic VAR, the augmented VAR are estimated with a constant and one lag on all variables.

4.2 Empirical Results

We first report the estimation results from the domestic VAR. Our main question is whether uncertainty shocks matter for real economic activity in Thailand, and if so, are there differences between the various types of uncertainty measures? However, we are also interested in analyzing the dynamic effects of uncertainty along various other dimensions, such as whether agents' forecasting horizon mat-

[6]Alternatively, U_t can be added second as in Bloom (2009), or last, as in JLN. We performed robustness checks according to these alternative orderings, and also experimented with adding additional economic variables to the VAR specification such as the nominal effective exchange rate. However, we did not find that these alternate specifications change the results in a qualitatively important way. Due to space considerations, results are available upon request.

[7]The information criterion suggests a larger number of lags but due to the short sample, the results reported here are based on a VAR with only one lag for all variables. Our findings are however, robust to longer lag specifications. Results are available upon request.

ters for uncertainty shocks and whether the response of real activity is symmetric for upside versus downside uncertainty. We tackle these questions first and leave our discussion for the main question last.

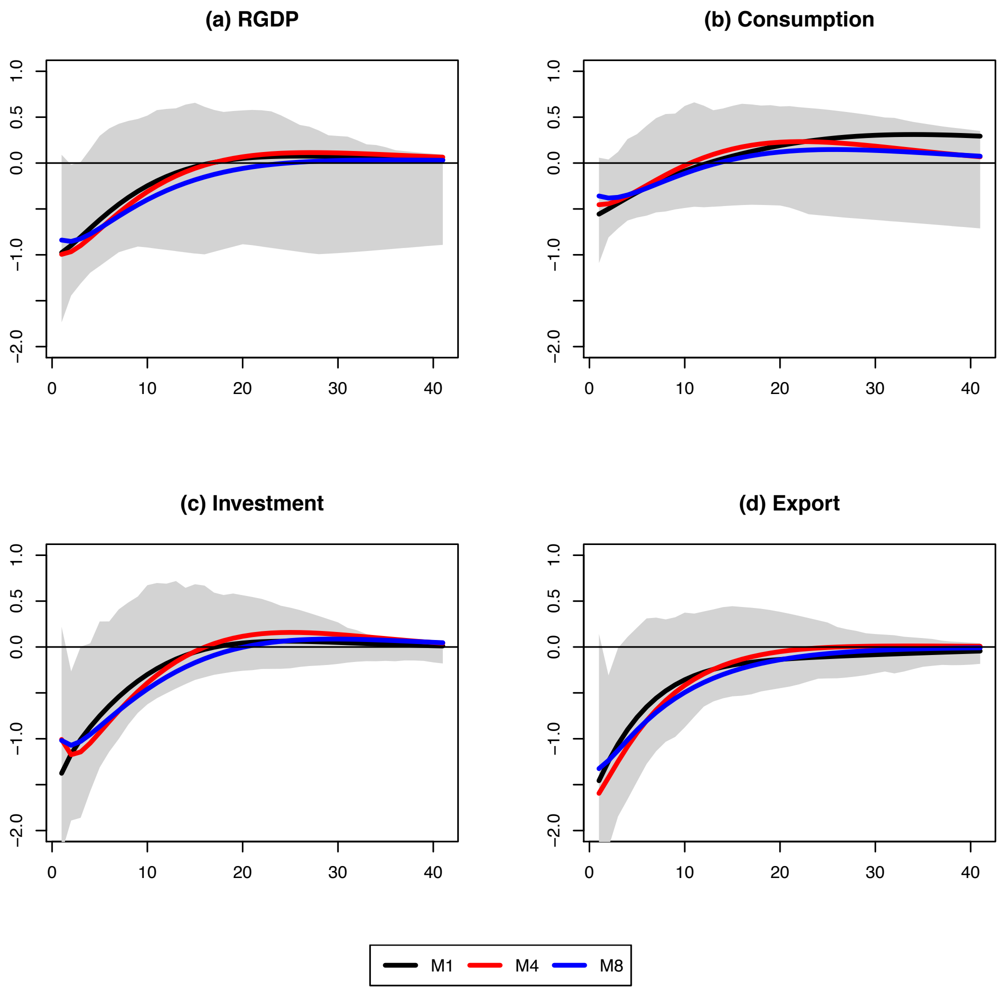
Figures 7 and 8 plot the dynamic responses of RGDP, C, I, and X to one standard deviation JLN-based macroeconomic and financial uncertainty shocks at the horizons $h = 1, 4$, and 8 quarters with shaded regions corresponding to 90 percent standard error bands. From the plots, aggregate uncertainty shocks have a statistically significant impact on real economic activity, but there are no observable differences in the effects across the various forecasting horizons. These findings, where short versus long run uncertainty appear to play similar roles on real economic activity are consistent with the findings of JLN for the US. Nevertheless, although this result may hold true at the aggregate level, there may be differences between the horizons of uncertainty that is worth exploring further at the micro level. For example, using firm-level data, Barrero et al. (2017) exploits information in the term structure of uncertainty across options of different durations and show that short versus long run uncertainty has different impacts on firm policies such as R&D and hiring.

While the term structure of uncertainty does not appear to matter for real activity in Thailand, there are however, discernible differences between the effects of upside and downside uncertainty shocks. According to Figure 9 which plots the response of real activity measures to positive, negative and total one-quarter ahead BOT economic uncertainty shocks ($BOT^{+}1, BOT^{-}1, BOT^{*}1$), $BOT^{*}1$ only marginally affects GDP and consumption[8]. Although the effects on investment and exports are stronger in magnitude, they are not very persistent. However, similar to the findings of RS for the US, once we distinguish between upside and downside uncertainty, we find that $BOT^{+}1$ and $BOT^{-}1$ have larger effects on real activity than the overall index. As expected, upside uncertainty is expansionary while downside uncertainty is contractionary, which underscores the importance of distinguishing between uncertainty in both directions as they deliver opposite effects on real activity.

In terms of whether asymmetry exists in downside versus upside uncertainty, we find that the effects are rather symmetric for RGDP and consumption. This finding is similar to those of RS for US output. For investments and exports however, the effects of uncertainty are asymmetric. More specifically, the magnitude of downside

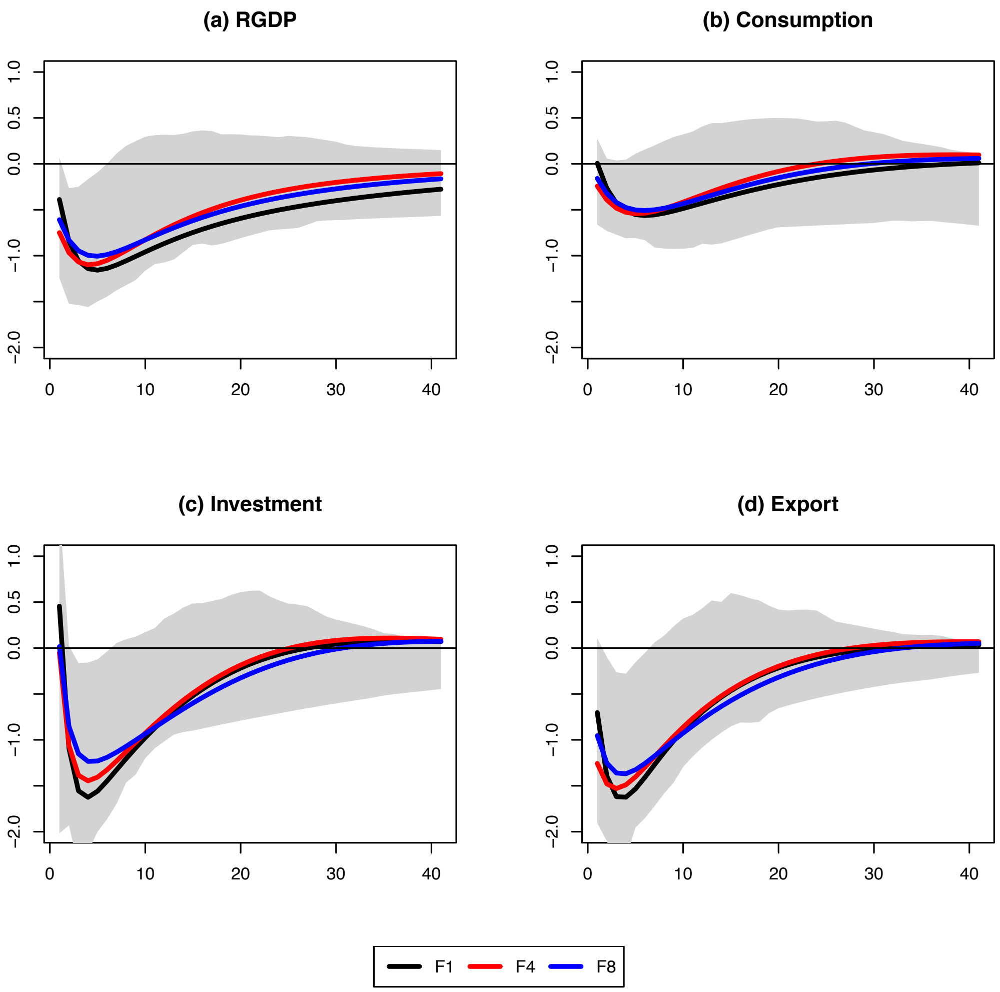
[8]We examine the effects of uncertainty from BOT fan charts for the horizons $h = 1, 4$, and 8 quarters, but similar to the results reported in Figures 7 and 8, the term structure of uncertainty does not appear to matter for the empirical results. Due to space considerations, we only show the findings that correspond to $h = 1$.

Figure 7: Impulse Response of RGDP and Components to Thai Macroeconomic Uncertainty Shocks



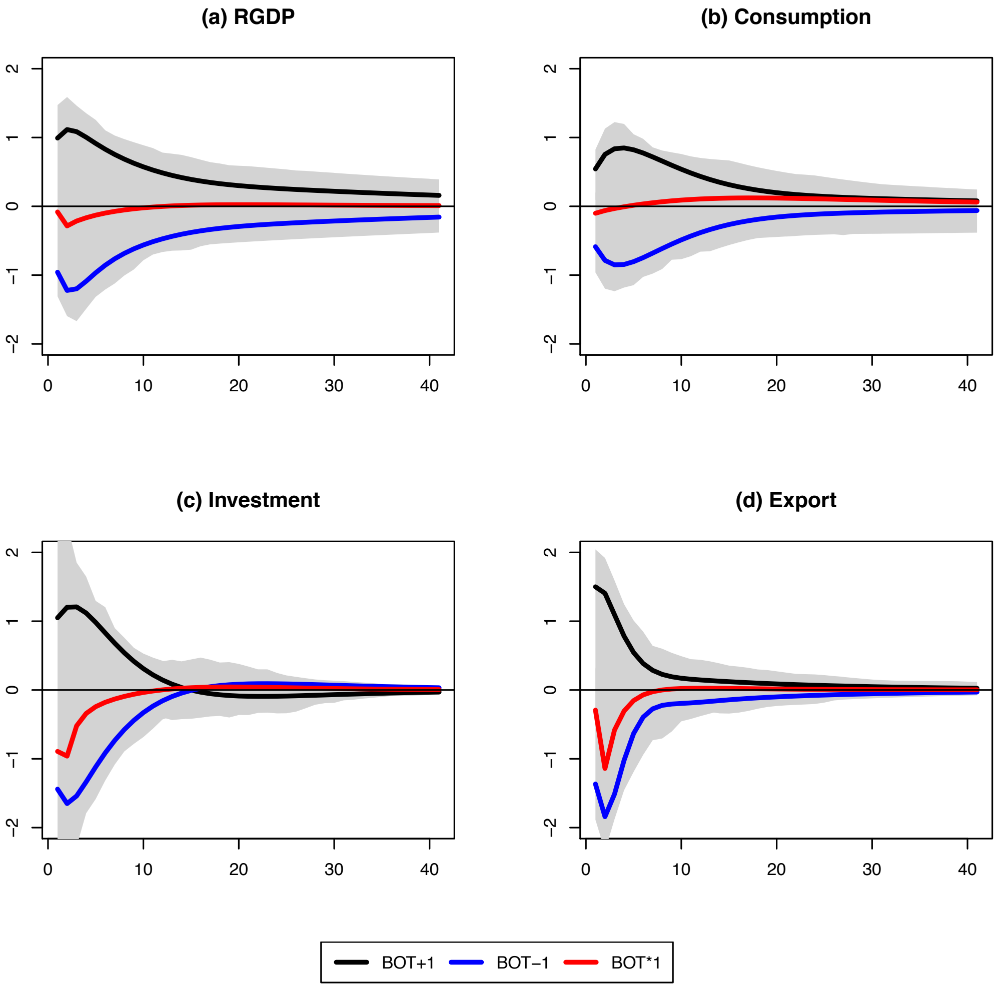
Note: Plotted are the impulse responses to JLN-based macroeconomic uncertainty shocks for Thailand at horizons $h = 1, 4$, and 8 quarters. The recursive VAR has the uncertainty measure ordered first, followed by the log of the SET50, the policy rate, the log of the CPI, and the log of the real activity measure. Shaded regions correspond to 90 percent standard error bands. The data is quarterly and spans 2002Q2-2017Q3.

Figure 8: Impulse Response of RGDP and Components to Thai Financial Uncertainty Shocks



Note: Plotted are the impulse responses to JLN-based financial uncertainty shocks for Thailand at horizons $h = 1, 4$, and 8 quarters. The recursive VAR has the uncertainty measure ordered first, followed by the log of the SET50, the policy rate, the log of the CPI, and the log of the real activity measure. Shaded regions correspond to 90 percent standard error bands. The data is quarterly and spans 2002Q2-2017Q3.

Figure 9: Impulse Response of RGDP and Components to BOT Economic Uncertainty Shocks



Note: Plotted are the impulse responses to one-quarter-ahead positive, negative and total RS-based economic uncertainty shocks for Thailand. The recursive VAR has the uncertainty measure ordered first, followed by the log of the SET50, the policy rate, the log of the CPI, and the log of the real activity measure. Shaded regions correspond to 90 percent standard error bands. The data is quarterly and spans 2002Q2-2017Q3.

uncertainty is larger than upside uncertainty by about half a percentage point. Based on alternative ways of identifying uncertainty, other studies have also found evidence of asymmetry in upside and downside uncertainty. Based on the VIX as a proxy, Foerster (2014) find that sizable increases in uncertainty have larger effects on economic activity than sizable decreases, implying that short-lived uncertainty episodes will have persistent effects on output growth and employment. Dahlhaus and Sekhposyan (2018) find that downside and upside uncertainty (defined as the federal funds rate being higher and lower than expected, respectively), strongly correspond to periods of monetary policy tightening and easing, and they find that periods of monetary policy tightening turn out to be more recessionary.

Finally, we come back to our main question where we are interested in assessing whether different proxies of uncertainty deliver the same effects on real activity. Our two final proxies of uncertainty, the TEPU and the TPCA, are plotted in Figure 10. Comparing the responses of real activity across all uncertainty measures, three key observations emerge. First, consistent with the findings in the literature, the impact of Thai uncertainty shocks on real activity is contractionary, that is, real activity declines following an aggregate uncertainty shock. However, we do not find evidence of the 'overshooting effect', where the initial drop in real activity is followed by a swift recovery and subsequent overshoot that surpasses its trend due to firms catching up on hiring decisions that were delayed by uncertainty. Note however, that this overshooting effect was mostly observed when financial indicators such as implied volatility were used as proxies for uncertainty (see Bloom (2009) for the US and Gourio et al. (2013) for G7 countries).

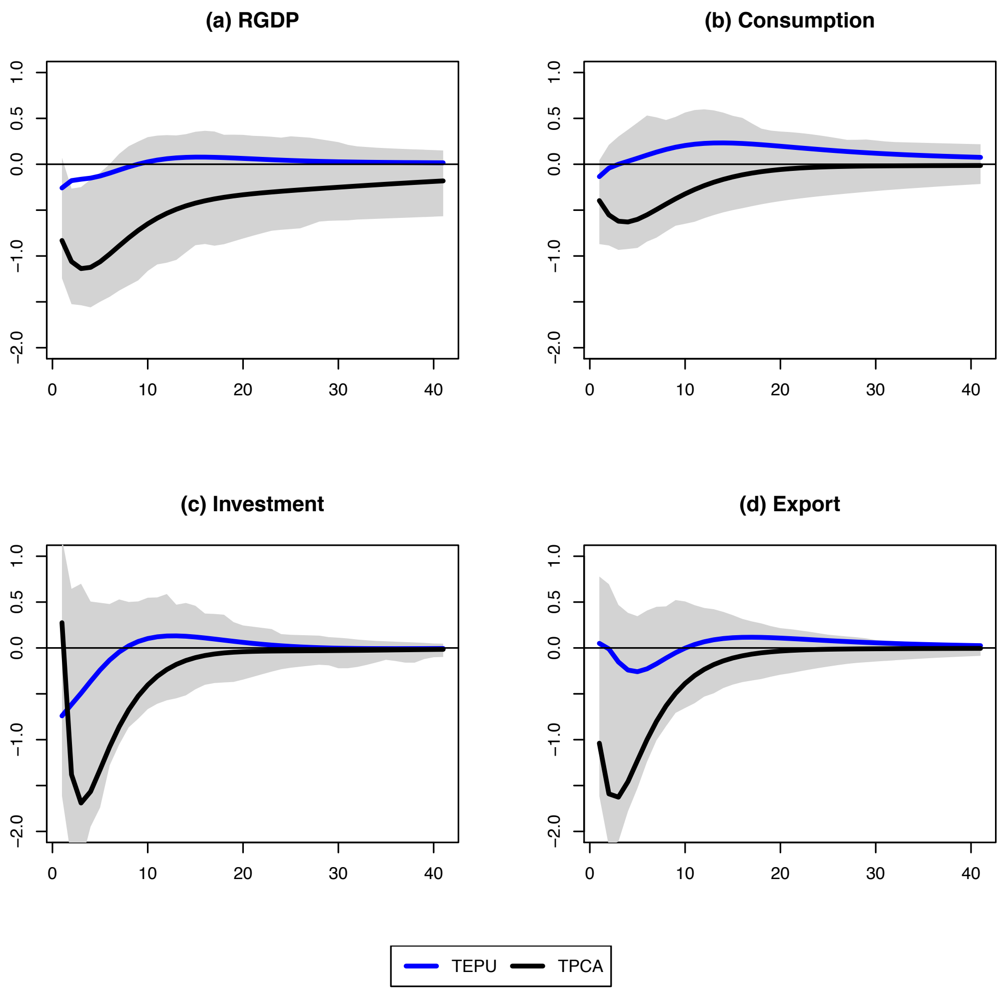
Second, there appears to be important differences in the dynamic responses of real activity to the various uncertainty proxies, especially in terms of persistence. For example, according to Figure 7, the effect of the JLN-based macroeconomic uncertainty shock is sudden, with all real activity measures contracting upon initial impact. The effect of the macroeconomic uncertainty shock also only takes about 20 quarters to fully subside. Compared with the results for the US, the JLN macroeconomic uncertainty shock is much more persistent, taking about 2-3 quarters to bottom out, with its effect persisting for longer than 5 years. The effect of the Thai financial uncertainty shock in Figure 8 however, occurs much more gradually than the macroeconomic one, taking about a year to fully bottom out and a total of 30 quarters to fully subside.

Downside BOT economic uncertainty and PC-based uncertainty shocks displayed in Figures 9 and 10 have dynamic impacts that are more in line with those observed for macroeconomic uncertainty. Their effects are more sudden and the shocks die out after approximately 20 quarters. Interestingly however, the news-based policy uncertainty measure in Figure 10 appears to deliver relatively little impact on the Thai economy. This is not surprising because in general, news-based uncertainty shocks have been found to have a relatively weak correlation with real activity. Some authors argue that media citations can be highly volatile, which can lead to misleading signals about the real effects of rises in uncertainty (see Forbes, 2016; Caldara et al., 2018).

Finally, while we observe some important differences in the persistence of uncertainty shocks, there appears to be little variation in terms of the full magnitude in which uncertainty shocks affects the various economic variables. With the exception of the TEPU which generates little to no impact on real economic activity, all other shocks decrease investment and exports by approximately 1.5 percent, and consumption by 0.5 percent. The decline in overall RGDP is about 1 percentage point. While it is difficult to compare these results with those of other countries due to differences in the sample period, VAR specification, as well as real activity variables used in the estimation, our results indicate that the full magnitude of uncertainty shocks for Thailand may be slightly stronger than those of advanced economies. For example, in the UK, the peak impact of a one standard deviation PC-based uncertainty shock on the level of GDP is around -0.5 percent (Haddow et al. 2013), while for Australia, various types of uncertainty shocks produce about one sixth of a percentage point decline in employment and retail sales growth. For Euro-area countries, Meinen and Roehe (2017) find that the amplitude in the drop of investment falls within the range of -0.5 to -1 percent following an uncertainty shock. An exception is the US, where the impact of a JLN macroeconomic uncertainty shock on production is as high as 2 percent.

Next, we investigate the estimation results from the augmented VAR which includes a foreign uncertainty shock. Three foreign shocks are taken into consideration and are added one at a time to in the augmented VAR: the US macroeconomic and financial uncertainty measure (M^*1 and F^*1) and the global news-based economic policy uncertainty measure (GPU). The premise behind this analysis is that a small open economy such as Thailand could exhibit strong comovements between domestic and foreign uncertainty shocks, thus it is plausible that the findings of sizable responses of real activity in the domestic VAR may merely be picking up the spillover effects of uncertainty shocks from abroad. Indeed, we find that our JLN-based macroeconomic and financial uncertainty shocks ($M1$ and $F1$) strongly comove with those of the US ($M1^*$ and $F1^*$), with correlation coefficients as high as 0.37 and 0.71 respectively. Other studies have documented high degrees of comovement among uncertainty shocks of different countries as well. For example, by constructing spillover measures in a VAR framework, Klößner and Sekkel (2014)

Figure 10: Impulse Response of RGDP and Components to PC-based and News-based Uncertainty Shocks



Note: Plotted are the impulse responses to news-based policy uncertainty and principal-component based aggregate uncertainty shocks for Thailand. The recursive VAR has the uncertainty measure ordered first, followed by the log of the SET50, the policy rate, the log of the CPI, and the log of the real activity measure. Shaded regions correspond to 90 percent standard error bands. The data is quarterly and spans 2002Q2-2017Q3.

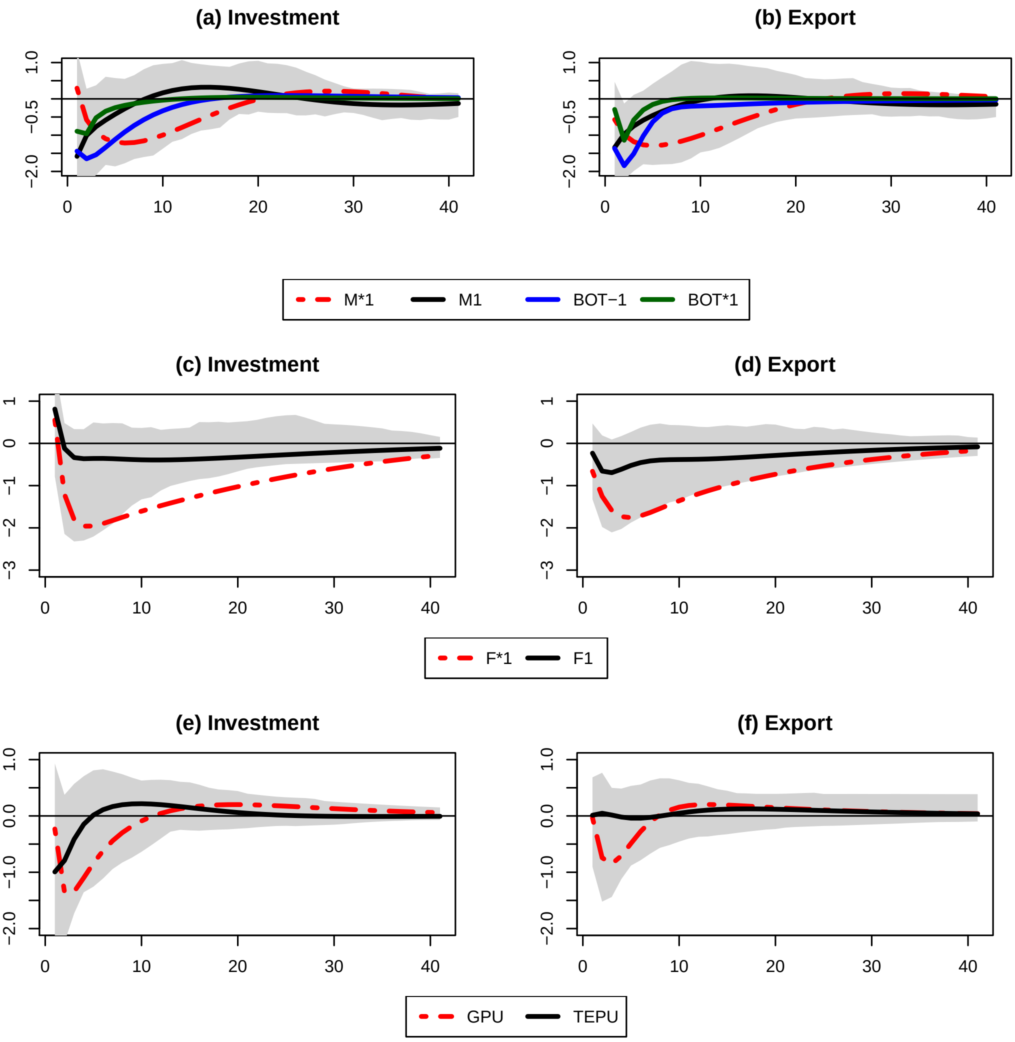
find that spillovers of policy uncertainty shocks account for more than a fourth of the dynamics of policy uncertainty in six developed countries, with this share rising to one-half during the GFC.

The estimation results from the augmented VAR are plotted in Figure 11. Due to space considerations, we only report how investment and export responds to an innovation in uncertainty, due to them being the two real activity measures that largely drive the contraction in real output. First, we examine the dotted line across all plots, which represents the impulse responses of real activity to foreign uncertainty shocks. We find that the dynamic impact of all foreign shocks are all significant and large, particularly for the US financial uncertainty measure ($F^{*}1$). This result echoes the findings of Carrière-Swallow and Cèspedes whom also document a significant impact of global uncertainty shocks on macroeconomic aggregates for 40 countries. Interestingly, they find that emerging economies suffer a more severe and persistent fall in investment than developed countries, which they explain may reflect the differences in access to finance and social safety nets in place.

Next, we focus on the relative importance of domestic versus global shocks from the VAR estimation results. Examining the plots in the first row, the US macroeconomic uncertainty shock ($M^{*}1$) generates falls in Thai real activity of comparable degrees to the domestic ones. However, in contrast to the sudden and sharp effects of all Thai macroeconomic uncertainty measures on investment and exports, the impact of $M^{*}1$ appears more gradual and persistent, taking about a year to bottom out and 5 years to fully subside. Interestingly, comparing the results here to those from the domestic VARs (see Figures 7 and 9), the real activity responses to $M1$, $BOT^{-}1$ and $BOT^{*}1$ barely change with $M^{*}1$ included, which imply that the effects of Thai macroeconomic uncertainty are largely independent from US macroeconomic uncertainty.

The results in the second panel suggest otherwise. Once the US financial uncertainty shock ($F^{*}1$) is added to the VAR, the effect of the Thai financial uncertainty shock ($F1$) declines substantially. This implies that financial uncertainty which drives contractions in the Thai economy are mostly imported from the US. We also observe that the impact of the US financial uncertainty shock is highly persistent, taking about 10 years to fully subside. Finally, in the last row of plots, we find that while the impact of the TEPU on economic activity remains quite marginal, the effect of global economic policy on the Thai economy is relatively large, which implies that global policy uncertainty shocks such as news about the US elections or Brexit may matter for the Thai economy. The decline of investment at its peak is almost as high 1.5 percent and as high as 1 percent for exports. However, its impact is still less persistent when compared to the effects of macroeconomic and

Figure 11: Impulse Response of RGDP and Components to Foreign versus Thai Uncertainty Shocks



Note: Plotted are the impulse responses to foreign and domestic macroeconomic, financial and economic policy uncertainty shocks. The recursive VAR has the global uncertainty measure ordered first, followed by the corresponding domestic uncertainty measure, the log of the SET50, the policy rate, the log of the CPI, and the log of the real activity measure. Shaded regions correspond to 90 percent standard error bands. The data is quarterly and spans 2002Q2-2017Q3.

financial based uncertainty shocks on investments and exports.

Our findings here add to a growing literature that examine the effects of global uncertainty shocks that spillover to domestic activity variables. So far, the empirical findings according to this strand of literature are still quite mixed. Similar in spirit to our study, Colombo (2013) and Moore (2016) examine how a US-based uncertainty shock may impact macroeconomic aggregates in the domestic economy based on a recursive VAR framework. The author finds that the effect of a shock to US EPU on Euro-based macroeconomic aggregates are quantitatively larger than ones exerted by Euro area news-based shocks. On the other hand, Moore (2016) finds that for the Australian economy, a one-standard deviation shock to US EPU has comparable effects to Australian-based news shocks.

A related literature also examines the effects of global uncertainty shocks by utilizing a dynamic factor model with stochastic volatility to extract a common measure of global uncertainty from a large set of financial and macroeconomic variables that span many countries. Based on this global component of uncertainty, Mumtaz and Theodoridis (2017) and Mumtaz and Musso (2018) find that country-specific uncertainty is more important than global uncertainty in explaining real output volatility in a large number of countries. Berger et al. (2016) on the other hand, report that global uncertainty is the major driver of macroeconomic performance in most countries with the impact of national uncertainty being small and frequently insignificant. Similar to us, they also find that uncertainty is transmitted primarily through investment and trade flows rather than through consumption demand. Given that the empirical findings for various countries and global uncertainty measures often conflict, further research on this topic is highly encouraged, in particular those that focus on trying to uncover the underlying driving factors behind the heterogenous results.

5 Conclusion

This paper provides an analysis of the role of uncertainty for real activity in Thailand. We apply well-known methods towards measuring uncertainty in the recent literature and propose five uncertainty proxies for Thailand: a news-based economic policy uncertainty index, aggregate macroeconomic and financial uncertainty measures, an economic uncertainty index consistent with the Bank of Thailand's future outlook of uncertainty, and an aggregate uncertainty measure that captures the first principal component of a wide range of uncertainty proxies that include sentiment indices and financial market volatilities.

All uncertainty measures under investigation display countercyclical behavior, but their dynamic impact on the economy varies. Based on a structural VAR analysis, we find that economic policy uncertainty only marginally impacts real activity. The effect of macroeconomic and financial uncertainty fluctuations on the other hand, contract real activity by a magnitude of 1-1.5 percent, with a particularly strong impact on investment and exports. While the peak effect of these aggregate uncertainty measures are more or less similar, financial uncertainty innovations are about 10 quarters more persistent than macroeconomic ones, and takes about 30 quarters to fully subside. We also find evidence of asymmetry, with downside uncertainty affecting the real economy more than upside ones, but we do not find any noticeable differences between the effects of short versus long term uncertainty shocks. Finally, we find that most of Thailand's financial uncertainty shocks are imported from the US, while macroeconomic and economic policy uncertainty are rather independent. Consistent with being a small open economy, we find that global uncertainty shocks along all dimensions - macroeconomic, financial and economic policy, play a sizable role towards driving Thailand's macroeconomic outcomes.

The implications of our findings are that for the Thai economy, uncertainty matters, and more importantly, the source of uncertainty matters as well. Our empirical findings have important policy implications. For example, given that macroeconomic uncertainty is predominantly driven by country-specific shocks, domestic policy measures are appropriate to mitigate the potential adverse effects. However, heightened financial and economic policy uncertainty mainly spillover from abroad, thus dealing with their effects might be beyond the control of national authorities. Nevertheless, it is important to monitor all sources of uncertainty to fully understand developments in macroeconomic fluctuations. Finally, from our findings, given the sizable and persistent impacts of financial uncertainty, exploring how uncertainty propagates through other channels and effects credit markets in Thailand may be an interesting avenue for future research.

6 Appendix A

The dataset used to construct the Thai macroeconomic and financial uncertainty indices according to JLN are monthly and quarterly series that span 2002-2018. Macroeconomic time series data are taken from the Bank of Thailand database while financial variables are from the Stock Exchange of Thailand. This appendix lists the name of each series in the dataset, as well as the transformation applied to each series to achieve stationarity. In total, we have 199 macroeconomic series that represent broad categories that describe the macroeconomy (Groups 1-10) and 22 financial series (Group 11), which are described in the table below. Each series has a corresponding transformation code, which follows either one of the following possible transformations:

Macroeconomic time series transformations:

1: $X_{it} = X_{it}^A$
2: $X_{it} = X_{it}^A - X_{it-1}^A$
3: $X_{it} = \Delta^2 X_{it}^A$
4: $X_{it} = ln(X_{it}^A)$
5: $X_{it} = ln(X_{it}^A) - ln(X_{it-1}^A)$
6: $X_{it} = \Delta^2 ln X_{it}^A$
7: $X_{it} = (X_{it}^A - X_{it-1}^A)/X_{it-1}^A$

where X_{it} denotes the transformed variable i, and X_{it}^A is the actual or raw data series. Note that we use the notation $\Delta = 1 - L$ and $LX_{it} = X_{it-1}$.

Financial time series transformations:

For the first five financial time series with transformation code 8, we follow the method as described below.

- $D\_log(DIV) : \Delta log D_t^*$
- $D\_log(P) : \Delta log P_t$
- $D\_DIVreinvest : \Delta log D_t^{re,*}$
- $D\_Preinvest : \Delta log P_t^{re,*}$
- d-p: $log(D_t^*) - log(P_t)$

Note that to obtain the dividend and price series, (D_t^* and P_t), we first construct the return series with dividends ($RETD_t$) and excluding dividends ($RETX_t$) as: $RETD_t = \frac{P_{t=1}+D_{t+1}}{P_t}$ and $RETX_t = \frac{P_{t+1}}{P_t}$, and produce a normalized price series based on the recursive rule: $P_0 = 1, P_t = P_{t-1} RETX_t$. A dividend series can then be constructed as: $D_t = P_{t-1}(RETD_t - RETX_t)$ where $D_t^* = (D_t + D_{t-1} + D_{t-2} + D_{t-3})$.

For dividends and prices under reinvestment, (D_t^{re*} and P_t^{re*}), we use the recursion $P_0^{re} = 1, P_t^{re} = P_{t-1} RETD_t$. Then, dividends under reinvestment can be defined as $D_t^{re} = P_{t-1}^{re}(RETD_t - RETX_t)$ where as before, $D_t^{re*} = (D_t^{re} + D_{t-1}^{re} + D_{t-2}^{re} + D_{t-3}^{re})$.

Finally, for the remaining 17 financial time series which are industry portfolios, the portfolio returns are constructed from the price and dividend yield series as follows:

$$R_{it} = \frac{P_{t+1} + D_{t+1}}{P_t}.$$

Table A1: List of Macroeconomic and Financial Variables

No.	Name and Description	Tcode
Group 1: National Account Data (Quarterly Series)		
1	Real Gross Domestic Product	5
2	Consumption	5
3	Government Consumption	5
4	Investment	5
5	Exports of goods and services	5
6	Imports of goods and services	5
Group 2: Output and Income (Monthly Series)		
7	PI:Personal Income	5
8	MPI: Manufacturing Production Index	5
9	MPI_10: Manufacture of food products	5
10	MPI_12: Manufacture of tobacco products	5
11	MPI_13: Manufacture of textiles	5
12	MPI_14: Manufacture of wearing apparel	5
13	MPI_15: Manufacture of leather and related products	5
14	MPI_19: Manufacture of coke and refined petroleum products	5
15	MPI_20: Manufacture of chemicals and chemical products	5
16	MPI_22: Manufacture of rubber and plastic products	5
17	MPI_23: Manufacture of other non-metallic mineral products	5
18	MPI_24: Manufacture of basic metals	5
19	MPI_25: Manufacture of fabricated metal products, except machinery and equipment	5
20	MPI_26: Manufacture of computer and electronic products	5
21	MPI_29: Manufacture of motor vehicles, trailers and semi-trailers	5
22	CAPU_10: Capital utilization of food products	2
23	CAPU_13: Capital utilization of textiles	2
24	CAPU_14: Capital utilization of wearing apparel	2
25	CAPU_15: Capital utilization of leather and related products	2
26	CAPU_17: Capital utilization of paper and paper products	2
27	CAPU_19: Capital utilization of coke and refined petroleum products	2
28	CAPU_20: Capital utilization of chemicals and chemical products	2
29	CAPU_22: Capital utilization of rubber and plastic products	2
30	CAPU_23: Capital utilization of other non-metallic mineral products	2
31	CAPU_24: Capital utilization of basic metals	2
32	CAPU_25: Capital utilization of fabricated metal products, except machinery and equipment	2
33	CAPU_26: Capital utilization of computer and electronic products	2
34	CAPU_29: Capital utilization of motor vehicles, trailers and semi-trailers	2
Group 3: Labor Markets (Monthly Series)		
35	Help Wanted	5
36	Help wanted/unemp	2
37	Emp (Total): Employed Total (Thousand)	5
38	Emp_nonag: Civilian Labor Force: Employed, Nonagricultural Industries	5
39	Unemployment Rate: Unemployment Rate: All workers	2
40	U_dr1m: Unemployment with duration less than 1 month	5
41	U_dr3m : Unemployment with duration between 1-2.9 months	5
42	U_dr6m: Unemployment with duration between 3-5.9 months	5
43	U_dr9m: Unemployment with duration between 6-8.9 months	5
44	U_dr12m: Unemployment with duration between 9-11.9 months	5
45	U_drmore12m: Unemployment with duration more than 1 year	5
46	Emp total-agri :Total employment in agricultural sector	5
47	Emp privatemanu: Private employment in manufacturing sector	5
48	Emp total-cons:Total employment in construction	5
49	Emp total_trade: Total Employment in Trade	5
50	Emp total_hotelrest:Total employment in hotel and restaurants	5
51	Emp private-fin:Private employments in financial sector	5
52	Private avg hour: Average working hours per weeks of private employees	5
53	Private earn_hr: Average earning per hour of private employees	5
54	Avg hr-private manu:Average working hours per weeks of private manufacturing workers	5
55	Avg wage-trade: Average earning per hour for private trade workers	5
56	Avg wage-fin : Average earning per hour for private financial workers	5
57	Avg wage-manu: Average earning per hour for private manufacturing workers	5

No.	Name and Description	Trans Code
Group 4: Housing (Monthly Series)		
58	Fee: Juristic Act and Right Registration Fee for Immovable Property (Millions of Baht)	5
59	Land licen: Land Development Licences - Bangkok Metropolis	5
60	Construction Area: Construction Areas Permitted (1000 sqm.)	5
61	Land Trans: Land and building Transactions Nationwide (Millions of Baht)	5
62	building licen: Building license	5
63	bld licen-bkk: Building license in Bangkok	5
64	bld licen-others: Building license in other provinces	5
65	New hous: New Housing Project in Bangkok Metropolis and Vicinity (unit)	5
66	housing proj: New Housing in Bangkok Metropolis and Vicinity (unit)	5
67	apartment: New apartment in Bangkok Metropolis and Vicinity (unit)	5
68	self built housing: New selfbuilt housing in Bangkok Metropolis and Vicinity (unit)	5
69	credit outstanding: Property Credit Outstanding (Millions of Baht)	5
70	re credit: Real Estate Development Credit	5
71	personal housing credit:Personal Housing Credit	5
Group 5: Consumption, Orders, and Inventories (Monthly Series)		
72	bsi: Business survey index	2
73	bsi_perf: Business survey index Performance	2
74	bsi_order: Business survey index Total Order Book	2
75	bsi_invest: Business survey index Investment	2
76	bsi_employment: Business survey index Employment	2
77	bsi_cost : Business survey index Production Costs (Invert)	2
78	bsi_3 month: Expected Business survey index over 3 month horizon	2
79	Retail Sales Index	5
80	Retail: Motor: Retail sales of motor vehicles and automotive fuel	5
81	Retail: Nondu: Retail sales of non-durable goods	5
82	Retail: Du: Retail sales of durable goods	5
83	Retail: Store: Retail sales of department stores, supermarkets, and general stores	5
84	Wholesales Index	5
85	whole sale: non du: Wholesales of non-durable goods	5
86	whole sale: du: Wholesales of durable goods	5
87	whole sale: int : Wholesales of intermediate goods	5
88	VAT - Gross Value Added Tax at 2000 prices (Million baht)	5
89	Sales: Automotives: Domestic automobiles sales	5
90	Sales: Clothes: Retail sale of clothing, footware and leather articles	5
91	Sales: Food: Retail sale of food in specialized store	5
92	Sales: Bev: Retail sale of beverages in specialized store	5
93	Sales: Tobacco: Retail sale of tobacco products in specialized stores	5
94	Sales: Electronics appliances: Retail sale of electrical household appliances in specialized stores	5
95	PII: Private Investment Index	5
96	Sales: Construction: Construction material sales index	5
97	Import: Capital: Imports of capital goods at 2010 prices	5
98	Sales: Machine: Domestic machinery sales at 2010 prices	5
99	PCI : Personal Consumption Index	5
100	Sales: Passenger Cars: Sales of passenger cars (units)	5
101	Sales: Motorcycle Sales: Sales of motorcycles (units)	5
102	Sales: Commercial Cars: Sales of commercial cars (units)	5
103	Gas Index: Sales of benzene, gasohol and diesel index	5
104	Electricity: Household electricity consumption index	5
105	Import: Clothes: Import of textiles index	5
106	Domestic Car Sales: Domestic automobiles sales (units)	5
Group 6: Money and Credit (Monthly Series)		
107	M1: Narrow money	7
108	M2: Broad money	7
109	Currency: Currency held by the public	7
110	Banknotes in Circulation	7
111	Deposit	7
112	Narrow Money	7
113	Currency Held by Depository Corp. - Commercial Banks	7
114	Transferable Deposits at Depository Corp. - Commercial Banks	7
115	Quasi-money	7
116	MLR: minimum loan rate (Min)	2
117	MLR minimum loan rate (Max)	2

No.	Name and Description	Trans Code
118	MRR: minimum retail rate (Min)	2
119	MRR: minimum retail rate (Max)	2
120	Government bonds (Total)	6
121	Treasury bills (Total)	7
122	Promissory notes (Total)	7
123	State enterprise bonds (total)	6
124	BOT-bond : Bank of Thailand bonds	6
125	Government debt securities held by nonfinancial market mutual funds	6
126	Outstanding government debt security	6
127	Total deposits outstanding of Commercial Banks	6
128	Deposits turnover ratio of Commercial Banks	2
129	Government bonds Short-term 1 year	6
130	Government bonds Medium-term 1-5 years	6
131	Government bonds Long-term 5 year up	6
132	Government promissory notes	6
133	State enterprise bonds Short-term 1 year	6
134	State enterprise bonds Medium-term 1-5 years	6
135	State enterprise bonds Long-term 5 year up	6
136	State enterprise promissory notes Short-term 1 year	6
137	New issuances of domestic securities	6
138	New issuances of domestic public sector securities	6
139	New issuances of domestic private sector securities	6
140	Authorized Capital of Newly Registered Companies	6
Group 7: Bonds and Exchange Rate Measures (Monthly Series)		
141	NEER: Nominal effective exchange rate	5
142	REER: Real effective exchange rate	5
143	inter_overnight: Interbank overnight lending rates	2
144	repo_1day: Bilateral repurchase rate (1 day)	2
145	repo_7days: Bilateral repurchase rate (7 days)	2
146	repo_14days: Bilateral repurchase rate (14 days)	2
147	Thai Baht implied interest rate (1 month)	2
148	Thai Baht implied interest rate (3 months)	2
149	Thai Baht implied interest rate (6 months)	2
150	tThai Baht implied interest rate (12 months)	2
151	Government bond yield (1 year)	2
152	Government bond yield (2 years)	2
153	Government bond yield (3 years)	2
154	Government bond yield (5 years)	2
155	Government bond yield (7 years)	2
156	Government bond yield (10 years)	2
157	Government bond yield (12 years)	2
158	Government bond yield (14 years)	2
Group 8: Prices (Monthly Series)		
159	CPI : Consumer price index	5
160	CPI-food: Consumer price index food and non-alcoholic beverages	5
161	CPI-apparel: Consumer price index apparel and foodwear	5
162	CPI-housing: Consumer price index housing and furnishing	5
163	CPI-med: Consumer price index medical and personal care	5
164	CPI-trans: Consumer price index transportation and communication	5
165	CPI-recre: Consumer price index recreation and education	5
166	CPI-tobacco: Consumer price index tobacco and alcoholic beverages	5
167	CPI-rawfood: Consumer price index raw food	5
168	CPI-energy: Consumer price index energy	5
169	CPI-ex food energy: Consumer price index excluding food and energy	5
170	CPI-ex food energy rent: Consumer price index excluding energy and rent	5
171	PPI : Producer price index	6
172	PPI_agri: Producer price index agricultural products	6
173	PPI_mining: Producer price index mining products	6
174	PPI_manu: Producer price index manufactured products	6
175	price_cons: Price of construction materials index	6
176	price_wood: Price of construction materials_wood	6
177	price_cement: Price of manufacturing goods_mixed cement 50 kgs.	6
178	price_metal: Price of construction materials_metal	6
179	price_diesel: Price of manufacturing goods_diesel	6
180	price_fueloil: Price of manufacturing goods_fuel oil	6
181	price_sugar: Price of manufacturing goods_white sugar (1 kg.)	6
182	price_rice: Wholesale price of 100% rice in Bangkok Metropolis	6
183	price_rubber: Wholesale price of ribbed smoked sheet rubber in Bangkok Metropolis	6

No.	Name and Description	Trans Code
Group 9: Stock Market Indices (Monthly Series)		
184	SET index: Stock Exchange of Thailand Index	5
185	SET Food Index	5
186	SET Bank Index	5
187	SET Energy Index	5
188	SET 50: SET 50 Index	5
Group 10: Trade (Monthly Series)		
189	Ex-volume: Export volume	5
190	Im-volume: Import volume	5
191	Im-cons: Import - Consumer Goods: Volume	5
192	Im-rawmat: Import - Raw Materials: Volume	5
193	Im-cap: Import - Capital Goods: Volume	5
194	Ex-agri: Export - Agricultural Products: Volume	5
195	Ex-fish: Export - Fishery Products: Volume	5
196	Ex-mfgs: Export - mfgs: Volume	5
197	Import goods excluding gold	5
198	Occupancy Rate	5
199	Tourists	5
Group 11: Financial Variables (Monthly Series)		
200	D_log(DIV): Dividend series based on	8
201	D_log(P): Price series based on	8
202	D_DivReinvest: Dividend under reinvestment based on	8
203	D_Preinvest: Price under reinvestment based on	8
204	d-p: Dividend to price ratio based on	8
205	AutoReturn: Automotive industry portfolio	8
206	FoodReturn: Food industry portfolio	8
207	FashionReturn: Fashion industry portfolio	8
208	HomeReturn: Home industry portfolio	8
209	PersonReturn: Personal goods industry portfolio	8
210	FinanceReturn: Finance industry portfolio	8
211	InsuranceReturn: Insurance industry portfolio	8
212	PetroReturn: Petroleum industry portfolio	8
213	PKGReturn: Packaging industry portfolio	8
214	PropertyReturn: Property industry portfolio	8
215	ENERGReturn: Energy industry portfolio	8
216	CommReturn: Commerce industry portfolio	8
217	HELTHReturn : Healthcare industry portfolio	8
218	MEDIAReturn : Media industry portfolio	8
219	TourismReturn: Toursim industry portfolio	8
220	TranReturn: Transportation industry portfolio	8
221	ETRONReturn: Electronics industry portfolio	8

7 Appendix B

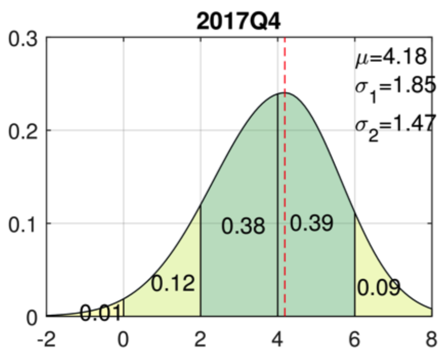
To uncover the underlying forecast distribution from the BOT fan chart, we assume that projections are constructed based on a two-piece or split normal distribution which is an approach quite common among central banks that publishes fan charts (Pońsko and Rybaczyk, 2016; Razi and Loke, 2017; Tay and Wallis, 2000). The split normal distribution has three parameters: a mode (μ), a left-hand-side standard deviation (σ_1), and a right-hand-side standard deviation (σ_1). Altogether, these parameters provide us with the following pdf:

$$f(x, \mu, \sigma_1, \sigma_2) = \begin{cases} Aexp(-\frac{(x-\mu)^2}{2\sigma_1^2}) & \text{if } x \leq \mu \\ Aexp(-\frac{(x-\mu)^2}{2\sigma_2^2}) & \text{otherwise} \end{cases}$$

where $A = \frac{\sqrt{2/\pi}}{\sigma_1+\sigma_2}$.

Based on the above specification, we draw a vast amount of random values for the three parameters and perform a grid search to find the best combination that gives us the closest match to the variable density in the fan chart. For example, from the fan chart in Figure 1, the split normal distribution that best describes the area under the density function for producing the forecast for 2017Q4 are governed by the parameters $\mu = 4.18$, $\sigma_1 = 1.85$ and $\sigma_2 = 1.47$ (see Figure B1). To obtain a series of forecast distributions that serve as inputs for the construction of the uncertainty measures according to RS, we perform such a process for every forecast round from 2000Q2 to 2017Q3.

Figure B1: Split Normal Distribution



Source: Authors' calculations.

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