ASSESSING THE EFFECT OF THE UNCERTAINTY ON EXCHANGE RATES: A QUANTILE REGRESSION APPROACH

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Trabajo de investigación 21/008

Master en Banca y Finanzas Cuantitativas

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UNIVERSITY OF VALENCIA

FACULTY OF ECONOMIC AND BUSINESS SCIENCES

MASTER IN BANKING AND QUANTITATIVE FINANCE

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MASTER THESIS

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02 de Julio de 2021

Abstract

We analyse the effects of US uncertainty on the entire distribution of seven of the most traded currency returns. To this end, we distinguish between news-based and econometric-based uncertainty indexes and we use quantile regression. The results suggest that, in general, the impact of news-based uncertainty measures is different to the impact of econometric measures. In addition, the impact of uncertainty is larger on the tails of the exchange rate returns distribution than in the mean, as well as asymmetric. Finally, we provide a characterisation of the tail behaviour corroborating some of the prevailing narratives about safe haven and risky currencies. The results are robust when we change the sample period, when we use bilateral exchange rates instead of nominal effective exchange rates and when we use an alternative proxy for uncertainty.

Keywords: exchange rates, tail asymmetry, uncertainty indexes, robustness test, quantile regression.

Resumen

En este trabajo analizamos los efectos de la incertidumbre estadounidense en toda la distribución de los rendimientos de siete de las divisas más negociadas. Para ello, distinguimos entre los índices de incertidumbre construidos basados en las noticias y construidos usando técnicas econométricas y utilizamos regresiones cuantílicas. Los resultados sugieren que, en general, el impacto de las medidas de incertidumbre basadas en las noticias difiere del impacto de las medidas econométricas. Además, el impacto de la incertidumbre es mayor en las colas de la distribución de los rendimientos del tipo de cambio que en la media, así como asimétrico. Por último, proporcionamos una caracterización del comportamiento de las colas que corrobora algunas de las narrativas predominantes sobre las divisas seguras y arriesgadas. Los resultados son robustos cuando cambiamos el período de la muestra, cuando utilizamos los tipos de cambio bilaterales en lugar de los tipos de cambio efectivos nominales y cuando utilizamos una aproximación alternativa para la incertidumbre.

Palabras clave: tipos de cambio, índices de incertidumbre, robustez, regresión cuantílica, asimetría.

Abbreviations and Acronyms

ADF	Augmented Dickey-Füller
AUS	Australian Dollar
CAD	Canadian Dollar
CBOE	Chicago Board Options Exxchange
CHF	Swiss Crown
Chicago FED	Chicago Federal Reserve
CNY	Chinese Yuan
EPU	Economic Policy Uncertainty
EUR	Euro
FED	United States Federal Reserve
FREU	Foreign Real Economic Uncertainty
FX	Forex
GARCH	General Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GPR	Geopolitical Risk
JB	Jarque Bera
JPY	Japanese Yen
KPSS	Kwiatkowski–Phillips–Schmidt–Shin
MPU	Monetary Policy Uncertainty
NEERRs	Nominal Effective Exchange Rates Returns
NEERs	Nominal Effective Exchange Rates

NFCI	National Finantial Condition Index
OLS	Ordinary Least Square
PP	Phillip Perron
PVAR	Panel Vector Autoregressive
SD	Standard Deviation
SVAR	Structural Vector Autoregressive
TPU	Trade Policy Uncertainty
UK	British Pound
US	United States
VAR	Vector Autoregressive
VaR	Value at Risk
VIX	Volatility Index

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1. Introduction

Since the Global Financial crisis in 2008, the effects of uncertainty on economic and financial variables have been of particular concern for many researchers. The interest of the uncertainty evaluation has been driven by a reformulation of the policy framework to make the financial structure more stable, and the increased availability of new empirical uncertainty proxies which differ in the sources of uncertainty and method of calculation. The first approach was developed by Jurado et al. (2015). These authors distinguish between uncertainty and volatility as terms that define different theoretical concepts. Uncertainty is the measure used to analyse the predictive ability of certain market variables, whilst volatility measures the returns dispersion of a specific asset. In this line, these authors document that financial assets returns may change over time due to specific conditions which contribute to increment volatility (leverage, risk aversion, productivity, etc.), even if the economic uncertainty essentials remain constant. Then, the prevailing narrative consider the uncertainty as the variable which affect to the economic fundamentals and study its predictability of the economy, such as the macroeconomic, trade or policy uncertainty variables. Furthermore, other authors study the differences between the different uncertainty proxies. For instance, Strobel (2015) shows that realized volatility-based uncertainty measures fluctuate more than the forecast-based uncertainty measures.

In the literature, a large number of uncertainty measures have been proposed. These measures differ mainly in the method of calculation and the uncertainty nature. The most relevant classification is the developed by Casaldi-Garcia et al. (2020). These authors review and summarise a huge survey of different uncertainty measures proposed in the previous literature classified depending on the procurement method, namely, the non-asset-market indicators (news-based, survey-based and econometric measures) and the asset-market indicators (realized volatility, derivative-implied risk, cross-sectional distribution, etc.). On the one hand, for the non-asset-market indicators, the news-based indexes include the different indexes which attempt to capture the uncertainty sentiment by counting the frequency of occurrence of some uncertainty-related terms in different news media, for example, the Economic Policy Uncertainty index (EPU) proposed by Baker et al. (2016), the Trade Policy Uncertainty index (TPU) proposed by Caldara et al. (2019), the Monetary Policy Uncertainty index (MPU) developed by Husted et al. (2017) and the Geopolitical Risk index (GPR) by Caldara and Iacovello (2018). The survey-based uncertainty indexes reflect probabilistic estimates via individual surveys of future economic outcomes and surrounding uncertainty. Most of them have focus on macroeconomic uncertainty and ex-post forecast errors (see Scotti, 2016; Bachmann et al. 2013; Mayasuki, 2016; Rossi and Sekhposyan, 2015; or Binder, 2017); other authors have based on a range of inflation forecast from a survey of professional forecasters, such as Grischenko et al. (2019). Finally, the econometric uncertainty indexes are based on the unforecastable component of the future variable defined by a h-period ahead uncertainty predictive variables. Some econometric uncertainty index examples are the Macroeconomic Uncertainty index (MAC) constructed by Jurado et al. (2015), the Foreign Real Economic Uncertainty index (FREU) developed by Londono et al. (2019) and the Financial Uncertainty index (FIN) proposed by Ludvigson et al. (2019). On the other hand, the asset-market indicators focus on different financial markets (stocks, derivatives, equity options, etc.) and are based on the realized volatility used for forecasting volatility (see Alizadeh et al., 2002; Corsi, 2009; Patton and Shephard, 2016) or the predicting returns (see, for example Bollerslev and Zhow, 2006).

Interestingly, the empirical literature has shown that the uncertainty measures mentioned above have different effects on the economy. For instance, many authors have researched the different response of the financials market to Macroeconomic and Financial Uncertainty (see Ludvigson et al., 2019). In general, these authors find that Macroeconomic Uncertainty is mostly linked to output shocks and plays an important role in recession periods, while the Financial Uncertainty is mostly linked to daily fluctuations and whether the economy is an expansive or recessive period. Some authors that have also documented a rich characterisation about the importance of distinguish the Macroeconomic and Financial Uncertainty are Carriero et al. (2018) and Londono et al. (2019). Other authors analyse how the Economic Uncertainty varies across economic dimensions. For example, Baker et al. (2016) examine the impact of the Economic Policy Uncertainty on the US and eleven major countries. These authors find several conclusions at different economic dimensions. At firm-level, the uncertainty reduces the investment and employment; at macro level, higher uncertainty leads to lower investment, output and employment; and at financial level, the increase of uncertainty can increase the stock volatility and co-movements, and equity premiums. Furthermore, other researchers have focused on the different impact of uncertainty indexes from the same group analysing different periods of time. For example, Rogers and Xu (2019) focus on the differences between real-time and ex-post uncertainty measures which capture the forecasting performance for real and financial variables. Likewise, there is another condition which could make the uncertainty impact differently, even if these belong to the same type. This condition is the country-specific indicator, which plays a crucial role in the analysis of the financial market uncertainty. For instance, Krol (2014) investigates the impact of country-specific economic and US Economic Policy Uncertainty on exchange rate volatility for ten industrial and emerging economies since 1990, finding differences between countries. For the industrial economies both types of uncertainty increase the currency volatility, but for the emerging countries only the country-specific uncertainty increases the volatility. Colombo (2013) compares the impact of the US-Euro Economic Uncertainty on the Euro area using a Structural Vector Autoregressive (VAR) model. This analysis is based on the study of Economic Policy Uncertainty developed by Baker et al. (2013) and conclude that US uncertainty is sharper than euro-specific uncertainty for the Eurozone when assessing the impact of these uncertainty measures impact on macroeconomic aggregates.

Likewise, it is crucial to understand the different effects of the uncertainty on the different financial markets. For example, various authors have focused on the commodity market. Watugala (2015) investigates the response of the commodity futures dynamics in emerging markets to the Economic Uncertainty. He analyses the relation between commodity volatility and uncertainty based on increased emerging market demand and macroeconomic forecast uncertainty. This author finds a significant predictability in commodity futures volatility using economic uncertainty variables. Bakas and Triantafyllow (2019) examine, based on the uncertainty measures of Jurado et al. (2015), the impact of uncertainty shocks on the commodity prices volatility through Vector Autoregressive (VAR) analysis. They show that these uncertainty measures have a persistent and positive impact on the commodity prices volatility, being the energy commodities the most affected. There is another branch of literature focusing on the effects of uncertainty in the bonds market. This research focus on the macroeconomic uncertainty as it is directly related to the bond prices. For instance, Asgharian et al. (2015) analyse the influence of the Macroeconomic Uncertainty Index (MUI), developed by Bali et al. (2014), on the long-run volatility and correlation of stock and bonds. These authors find that, using the mixed data sampling and GARCH-MIDAS model, the Macroeconomic Uncertainty induces to a flight-to-quality[1] behaviour. In the interest rates field, Hartzmark (2016), highlights the strong relationships between the real risk-free interest rates and the Macroeconomic Uncertainty in the long run using linear regression. Likewise, several authors examine the stock market. For instance, Chuliá et al. (2017) propose a new daily financial index to study the uncertainty in the stock market. These authors find that the Financial Uncertainty impact is negative and persistent in this market, and also can affect to macroeconomic variables. Other researchers, such as Simpson (2020), analyse the Volatility Index (VIX) proposed by the Chicago Board Options Exchange (CBOE) in various markets. This author analyse the VIX as the investors uncertainty in the long run based on their expectations, finding that VIX could drive to different investment strategies in the different markets, such as in the options market.

Beyond that, being the foreign exchange rate the largest and most liquid financial market, it is crucial to understand from a policymaker, investor and exporter and importer perspective, how the different types of uncertainty influence on the exchange rates dynamics. The main reason resides in the constitution of exchange rates as relative prices. Thus, the exchange rates fluctuation is subject to gain and losses of competitiveness compared to a reference currency(ies). Misunderstanding these effects of the uncertainty on exchange rates could have a large impact on the economy. Thereby, many authors have studied the impact of uncertainty on this financial market by means of linear regression. Iyke and Ho (2017) document how the exchange rates uncertainty affects to the domestic investment in the short and long run using linear regression. These authors finds that there exists evidence on the different impact whether we assess the uncertainty in the short run or in the long run. In this line, Abid (2020) examines the effects of the Economic Uncertainty on the exchange rates distinguishing between the short and long run in emerging countries. Chang (2011)

[1] *Flight-to-quality* occurs when investors begin to shift their asset allocation from riskier investments to safer ones investment, such as from stocks to bonds. This definition is extracted from Chen (2020).

compares two different measures of uncertainty, namely, the moving average standard deviation and general autoregressive conditional heteroskedasticity (GARCH), to analyse the effect of exchange rates uncertainty on employment. Aguiar de Oliveira (2013) concludes that the uncertainty impact on exchange rates can also be different among the different exchange rate regimes. This author finds that there exist discrepancies among the exchange rates regimes, so understanding the impact of uncertainty measures is very important in order to make the economy more stable by studying these predictive indicators.

Other papers have focused on the foreign exchange market using vector autoregressive (VAR) models to analyse the impact of different types of uncertainties on the dollar-based real exchange rates. Benigno et al. (2012) study the impact of domestic uncertainties (Monetary Policy Uncertainty, inflation-target and volatility of productivity) on the G7 countries, finding several evidences of the time-varying impact of these shocks on the exchange rates using VAR and panel VAR models. Sin (2015) applies the same approach based on a VAR model to study the causal effect of shocks on Chinese Economic Uncertainty on the real exchange rates of Taiwan and Hong Kong relative to the Chinese Yuan. This author concludes that exist differences in the short-run and long-run effects of the Economic Uncertainty in these exchange rates.

These studies have addressed the effects of uncertainty only in mean, ignoring the possibility that the impact of uncertainty might vary across the entire distribution. Only a scarce literature directly analyses the uncertainty impact on the entire distribution of exchange rates, which reach a crucial conclusion: there is evidence on the asymmetric impact of uncertainty across the entire distribution. On the one hand, Balcilar et al. (2016) examine the impact of the US Economic Policy Uncertainty on the predictability of the US dollar-based exchange rates using a Causality-in-Quantiles test for developed and developing countries. They find that EPU presents predictive ability for exchange rate returns and variance, as well as that, the casual impact on the variance for some US dollar-based exchange rates varies across the conditional distribution. On the other hand, Chen et al. (2020) study the impact of the Economic Policy Uncertainty on the Chinese exchange rate volatility using quantile regressions. These authors find that there exists asymmetry related to the exchange rate volatility. In addition, Eugen-Martin and Sokol (2020) is the first paper to document how global financial conditions, measured as the common component of country-specific financial conditions, affect the exchange rate returns distribution of different developed and emerging market economies, validating some of the prevailing literature on safe haven and risky currencies, developed by Ranaldo and Soderlind (2010). Concretely, these authors document the currency properties based on factor models studying the link between the exchange rates, stock and bond markets since 1993 until 2008. They find that the Swiss Crown and the Japanese Yen are safe haven currencies in the analysed period.

Given (i) the exchange rates importance in the policy and investment frameworks, (ii) the evidence that different measures of uncertainty can have different impacts on financial and economic variables depending on the uncertainty nature and, (iii) the importance of studying the asymmetry effects of uncertainty over the entire distribution, in this paper we analyse the effects of the different uncertainty measures over the exchange rates entire distribution. The contributions of this paper to the previous literature are twofold. First, we analyse the impact of both, news-based and econometric measures, on exchange rates. On the one hand, within the news-based uncertainty we use the Monetary Policy Uncertainty (MPU) index proposed by Husted et al. (2020), the Trade Policy Uncertainty (TPU) index proposed by Caldara et al. (2019), the Geopolitical Risk (GPR) index developed by Caldara and Iacovello (2018) and the Economic Policy Uncertainty (EPU) index proposed by Baker et al. (2016). On the other hand, within the econometric measures, we select the Financial Uncertainty (FIN) and Macroeconomic Uncertainty (MAC) measures developed by Ludvigson et al. (2019) based on Jurado et al. (2015). All these measures refer to US uncertainty. This choice is based on the fact that US uncertainty can be considered to be a general indicator of global uncertainty and to avoid endogeneity problems in the estimation procedure. Our second contribution is that we analyse the effects of these uncertainty indexes across the entire distribution (and not only in the mean) of exchange rates using quantile regressions. We use the nominal effective exchange rates (NEERs) in order to avoid biased results as we are considering measures based on the US uncertainty, which could affect indirectly to the US bilateral exchange rates. We use a database of seven of the most traded currencies, concretely, we use the currencies of Australia, Canada, China, Eurozone, Japan, Switzerland and United Kingdom. To the best of our knowledge, this is the first paper that analyses how the exchange rates respond to different types of uncertainty over the entire distribution.

The main results can be summarized as follows. First, we find that the different uncertainty indicators capture different information and they play a crucial role in signalling the particular dynamics of the exchange rates over time and establishing currency-specific patterns. Particularly, the results suggest that the impact of news-based uncertainty measures is different to the impact of econometric measures with the exception of EPU, whose impact is similar to the econometric measures, proving the different impact of uncertainty depending on its nature. Second, we find evidence on the importance of study the effects in the tails of the exchange rates as we observe asymmetric effects across the distribution depending on the uncertainty measures and currencies, proving that the quantile regression is highly appropriate. Lastly, we find that some currencies behave as hedge currencies (safe haven) in unstable periods, such as the Swiss Crown or the Japanese Yen; while the Australian Dollar is found to be the riskiest currencies of our currency basket, in line with Ranaldo and Soderlind (2010). Nevertheless, as we use a different period from the previous paper, we find some discrepancies among these currencies.

Finally, we prove that these results are robust in general when: (i) we change our original baseline period for a more stable period from 2011:01 to 2019:12, excluding all the prior extreme events including the Global Financial crisis in 2008 and the COVID-19 from the sample period; (ii) we analyse the effects of uncertainty on bilateral exchange rates, being the domestic currency the US Dollar; and (iii) we use a new proxy for uncertainty based on the US financial conditions, namely, the National Financial Conditions Index (NFCI) developed by the Federal Reserve Bank of Chicago. Beyond this general robustness, we find peculiarities for some currencies across these three tests which make the conclusions more interesting.

The rest of the paper is organized as follows: *Section* 2, describes the uncertainty indexes. In *Section* 3, we present the nominal effective exchange rates, the analysis of its stationarity and summary statistics. In *Section* 4, we explain the methodology based on quantile regression. In *Section* 5, we present and discuss the empirical results. In *Section* 6, we further show and discuss the Robustness Tests. Finally, a *Section* 7 is set to resume all the information as a final conclusion.

2. Uncertainty Indexes

Our analysis is based on two different sets of uncertainty regarding to the US uncertainty: news-based and econometric uncertainty indexes. Data on the news-based uncertainty measures is available at the *Economic Policy Uncertainty* website (https://policyuncertainty.com/)[2] and data on econometric uncertainty indexes is obtained from *Sydney Ludvigson* website (https://www.sydneyludvigson.com/). Both groups of indexes cover the period from 1999:01 to 2020:12. The sample period is determined by the nominal effective exchange rates monthly data availability. News-based uncertainty indexes consist of the *Economic Policy Uncertainty* index (EPU) proposed by Baker et al. (2016), the *Monetary Policy Uncertainty* index (MPU) developed by Husted et al. (2020), the *Trade Policy Uncertainty* index (TPU) proposed by Caldara et al. (2019), and the *Geopolitical Risk* index (GPR) developed by Caldara and Iacoviello (2018). Econometric uncertainty indexes include the *Financial Uncertainty* (FIN) measure and the *Macroeconomic Uncertainty* (MAC) measure proposed by Ludvigson et al. (2019) based on Jurado et al. (2015).

2.1. News-based uncertainty indexes

The Economy Policy Uncertainty index (EPU) was proposed by Baker et al. (2016). These authors develop an index for U.S from 1985:01 to 2020:12[3]. The index is constructed from three components. The first component measures US newspaper coverage of several terms related to uncertainty and economy. They focus on 10 leading newspapers which are: *USA Today, Miami Herald, Chicago Tribune, Washington Post, Los Angeles Times, Boston Globe, San Francisco Chronicle, Dallas Morning News, New York Times, and Wall Street Journal*. The related words are: *"economic"* or *"economy"; "uncertain"* or *"uncertainty";* and one or more of *"congress", "deficit", "Federal Reserve", "legislation", "regulation"* or *"White House" (including variants like ''uncertainties,'' ''regulatory,'' or ''the Fed").* Once these authors selected the principal terms, they scale the raw counts by the total frequency of articles in the same newspaper and month, then standardise each monthly

[2] Some indexes are obtained from the authors website. We remark this point when describing the particular uncertainty index.

[3] The EPU index is updated monthly by the authors, so we had access to updated-to-present data.

series to a unit standard deviation and normalize to a mean of 100 to calculate by computation from this normalization the EPU index. The second component is based on the number of federal tax code provisions set to expire in future years. Finally, the third component reflects disagreement among economic forecasters as a proxy for uncertainty (see Baker et al., 2016 for more information on this index).

The Monetary Policy Uncertainty index (MPU) was proposed by Husted et al. (2017). This index measures the uncertainty about Federal Reserve monetary policy actions from 1985:01 to 2017:05[4]. The data on MPU is available at the authors website (https://sites.google.com/site/lucasfhusted/data). These authors collect the frequency of newspaper articles related to MPU registered in ProQuest Newsstand and historical archives. These keywords are divided in three categories: (i) *"uncertainty" or "uncertain",* (ii) *"monetary policy(ies)"* or *"interest rate(s)"* or *"Federal fund(s) rate"* or *"Fed fund(s) rate," and* (iii) *"Federal Reserve" or "the Fed"* or *"Federal Open Market Committee"* or *"FOMC*". They repeat the process every day for the *Washington Post*, *Wall Street Journal*, and *New York Times*. To standardise the index, they control the changing volume covering of monetary policy of each newspaper dividing the raw count by the total number of new articles mentioning any word from category (iii). Once they have scaled it, they normalise the index to have a unit standard deviation and aggregate it by summing the previous results and rescaling to a mean of 100 (see for more information the original paper, Husted et al., 2017).

The Trade Policy Uncertainty index (TPU) was proposed by Caldara et al. (2019). It is a monthly index constructed by counting the frequency of joint occurrences of trade policy and uncertainty terms across major newspaper since 1960:01[5]. Firstly, the authors construct a *firm-level* index in which, they search transcripts for related terms of trade policy and then measure, for each transcript, the frequency of trade policy words. Then, the authors isolate the discussions about TPU by selecting the positive returns and aggregate the data. The final aggregate index represents the monthly proportion of articles discussing about TPU (see for more information the original paper, Caldara et al., 2019). Some of the newspaper according to the original article are

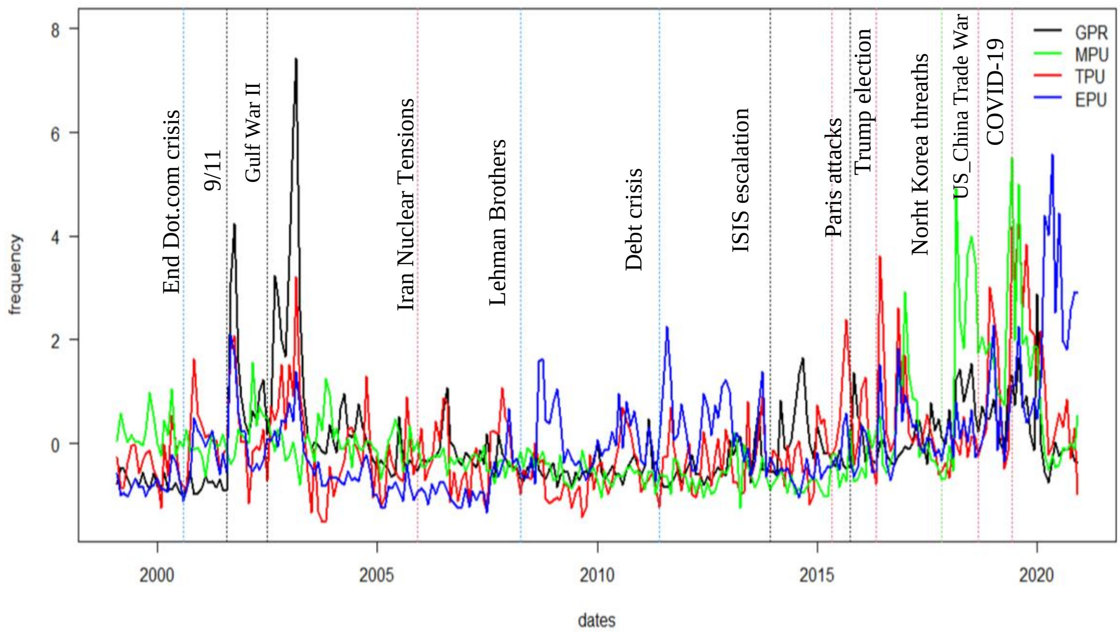
[4] The MPU index is updated monthly by the authors, so we had access to updated-to-present data.

[5] The TPU index is updated monthly by the authors, so we had access to updated-to-present data.

Boston Globe, Chicago Tribune, The Guardian, The New York Times, Wall Street Journal and *The Washington Post*.

The index of Geopolitical Risk (GPR) was proposed by Caldara and Iacovello (2018). The index is constructed at a monthly frequency by counting the occurrence of words related to geopolitical tensions and stress since 1985:01 to monthly updated-to-present data on 11 leading English-language international newspapers in electronic archives on ProQuest Newsstream: *The Boston Globe, Chicago Tribune, The Daily Telegraph, Financial Times, The Globe and Mail, The Guardian, Los Angeles Times, The New York Times, The Times, The Wall Street Journal*, and *The Washington Post*. The authors calculate the index by counting, for each month, the number of articles considering an increase in political hazards, which normalise to a value of 100 on average over the decade 2000-2009.The study identifies six group of words: (i) explicit mentions of geopolitical risk and military words (U.S involvement), such as "*geopolitical" or "United States"*, (ii) explicit nuclear tensions terms, for example, "*menace*" or "*atomic war*", (iii)-(iv) war threats and terrorist threats, such as "*war risk*" or "*terrorist threat*", respectively, and (v)-(vi) the beginning of war and terrorist attacks,, for example, "*(outbreak) of the war*" or "*Terrorist act*", respectively.

Figure 1. News-based Uncertainty indexes dynamics.



Note. We show the evolution of the normalized news-based uncertainty indexes, which include the Geopolitical Risk (GPR) index by Caldara and Iacovello (2018), the Monetary Policy uncertainty (MPU) index by Husted et al. (2017), the Trade Policy Uncertainty (TPU) index by Caldara et al. (2019) and the Economic Policy Uncertainty (EPU) index by Baker et al. (2016). The sample period goes from 1999:01 to 2020:12. Crucial events are marked by vertical lines.

Figure 1 shows that the increment of uncertainty is directly related to critical events. The GPR, the EPU and the MPU indexes present a spike around 9/11 and Gulf War II events and all indexes spiked around the beginning of the COVID-19. Likewise, some of these indexes respond to other crises, such as the TPU and MPU indexes, which seem to be the indexes that reflect the US-China Trade War since around 2018 onwards and, the EPU index, which is the only that sharply increases during the global financial crisis around 2008. Then, it is crucial to consider the nature of the uncertainty as it may be associated with particular events.

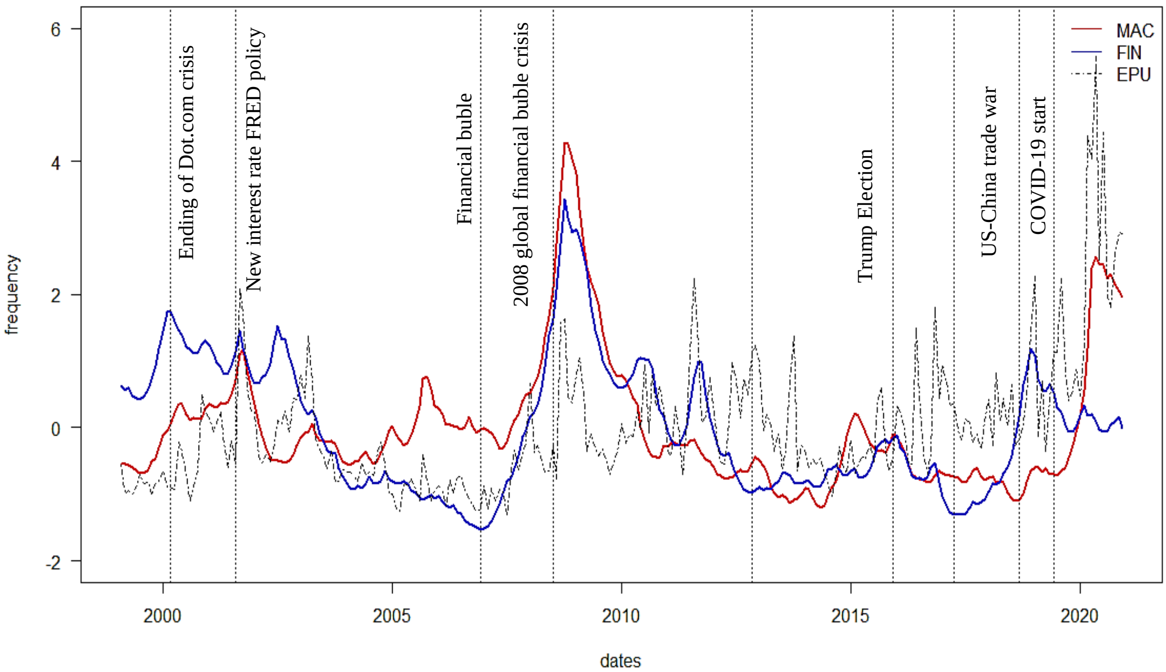
2.2. Econometric uncertainty indexes

Econometric uncertainty measures include the updated monthly version of the Macroeconomic Uncertainty index (MAC) and the Financial Uncertainty index (FIN), developed by Ludvigson et al. (2019). Both indexes measure the uncertainty based on the approach used in Jurado et al. (2015). These authors model the common component of the time-varying variance from the forecast errors of 134 macroeconomic series and 148 financial series. These indexes are available at the *Sydney C. Ludvigson* website (https://www.sydneyludvigson.com/). Beyond the methodology described in Jurado et al. (2015), in Ludvigson et al. (2019), the methodology is based on the capture of predictable variations using VAR models from these datasets. These authors construct the indicators using predictors h-period ahead ($h = 1, 3, 12\, month(s)$), in which uncertainty increase with h. We work with the $h(1)$-period ahead as our benchmark as in Ludvigson et al. (2019). The sample period goes from 1999:01 to 2020:12.

We show in Figure 2, the Macroeconomic and Financial Uncertainty indexes. The Financial uncertainty index seems to capture sooner and distinctly the instability effects for various main events. For instance, we notice this distinction as we observe an upwards trend in the Financial Uncertainty index around 2017 and in the Macroeconomic Uncertainty index around 2019, coinciding with the US-China Trade War and incipient COVID-19, respectively. The lag in the Macroeconomic Uncertainty response to a shock event is evidenced around 2003, coinciding with the Gulf War II, and the large spike around 2008, coinciding with the Global Financial Crisis.

Lastly, if we compare the econometric indexes with the EPU index, we see an analogous pattern around 2008 and 2019, coinciding with the global financial crisis in 2008 and the starting of COVID-19. Moreover, EPU seems to oscillate more than econometric-based measures since 2010 onwards, reaching its global maximum with the COVID-19 (2020) and showing a policy unstable period. In addition, the EPU index behaves similar to the Financial Uncertainty index in previous periods to the major crises. For instance, we observe that exist some similar dynamics prior to the global financial crisis in 2008 and COVID-19; nevertheless, the EPU and the Macroeconomic Uncertainty became more similar at the start of the COVID-19. The its clear that the Macroeconomic Uncertainty is related to the critical economy events, while the Financial Uncertainty is more related to the daily fluctuations.

Figure 2. Econometric-based uncertainty indexes dynamics.



*Note***.** We show the evolution of the normalized Financial Uncertainty index (FIN) and the Macroeconomic Uncertainty index (MAC), by Ludvigson et al. (2019), compared to the Economic Policy Uncertainty (EPU), by Baker et al. (2016), for the period from 1999:01 to 2020:12.

3. Data

In this study, we analyse the impact of US uncertainty indexes on seven of the most traded currencies according to the *Corporate Finance Institute* (CFI). Concretely, our dataset comprises the nominal effective exchange rates (NEERs) of Australia (AUS), Canada (CAD), China (CNY), Eurozone (EUR), Japan (JPY), Switzerland (CHF), and United Kingdom (UK) of a basket of sixty of the major international currencies. The data have been obtained from the *Bank of International Settlements* (BIS)[6], for the period of 1999:01 - 2020:12. Following the Eguren-Martin and Sokol (2020) methodology, we use NEERs in order to avoid the US-driven changes in bilateral dollar exchange rates and interest rate differentials, by focusing on the plain exchange rates moves. Likewise, we use the monthly US dollar bilateral exchange rates (U.S dollar/foreign currency[7]) as a robustness test (see *Section* 6). The data on bilateral exchange rates are obtained from the *Federal Reserve of St. Louis* (FRED)[8]. We construct a partial sample for China for both exchange rate sets starting from 2005:01, as China switched from fixed exchange rate policy into a limited flexible policy with US.

Figure 3 shows the evolution of the NEERs dynamic over the sample period. Upwards (downwards) movements correspond to appreciations (depreciations) of the NEERs respect with the international basket. Apparently, series are non-stationary, then we work with the nominal effective exchange rate returns (NEERRs)[9], which in turn, are found to be stationary based on the standard Unit Root test (see *Subsection* 3.1).

Interestingly, we identify two fundamental unstable periods for all the currencies. The first is a more general unstable period driven by the financial system collapse in 2008, and the second is more characteristic to each currency. Then, generally, around the global financial crisis in 2008, the Asian countries, Switzerland, and the United Kingdom react sharply positively (appreciations), while Canada, Eurozone, and Australia react sharply negatively (depreciating). This shock seems to be temporary except for the Eurozone, as it never recover the *prior-to-crisis* value.

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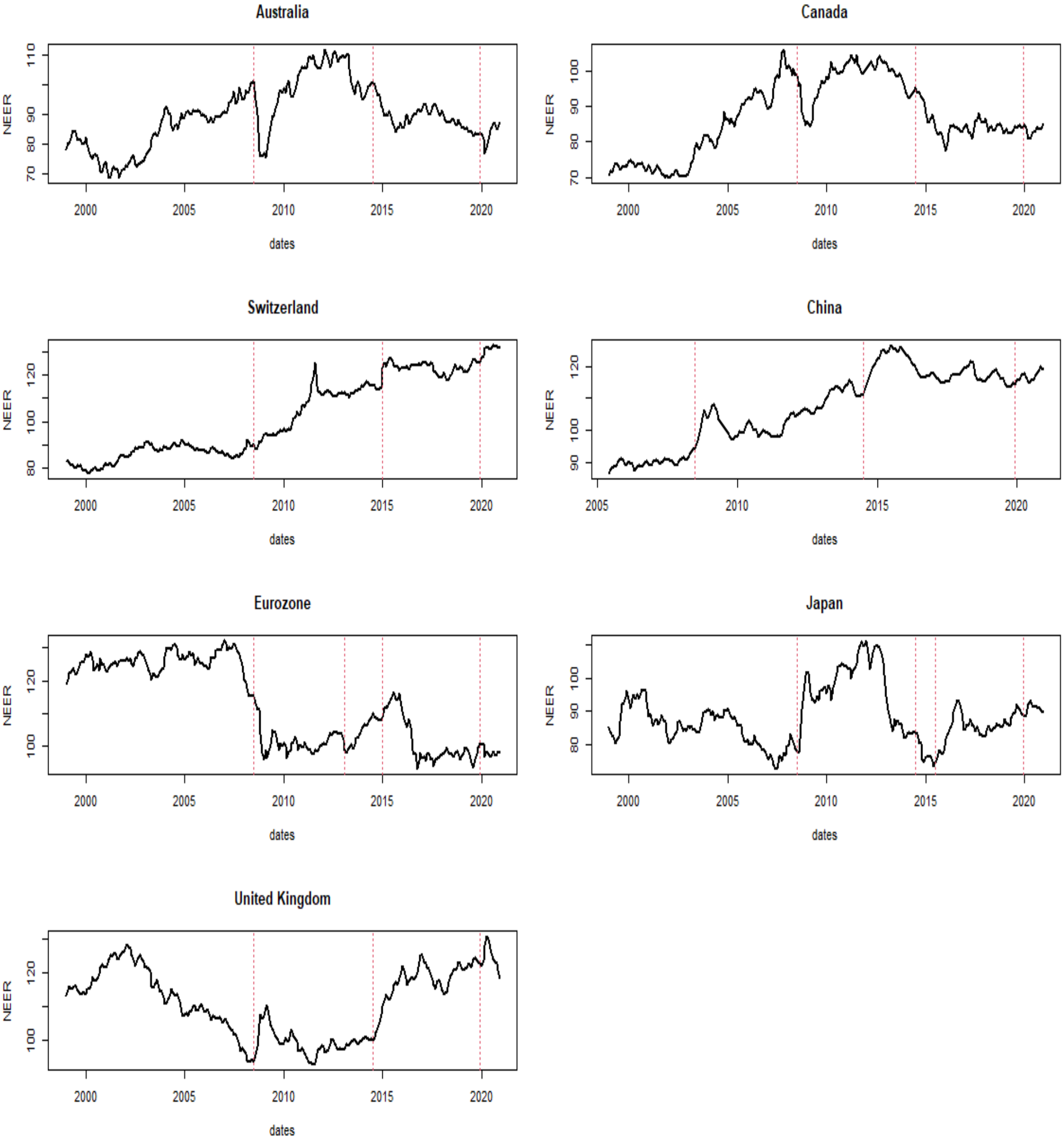
[6] The data is obtained from the website of the BIS (https://www.bis.org/statistics/full_data_sets.htm).
[7] The foreign currencies consists of the different selected currencies in this paper.
[8] The data is obtained from the website of the FRED (https://fred.stlouisfed.org/categories/158).
[9] The nominal effective exchange rates returns (NEERRs) are plotted in *Section* 9*:* Annexes.

Figure 3. Nominal effective exchange rates (NEERs) evolution.



Note. We show the nominal effective exchange rates (NEERs), for the period from 1999:01 to 2020:12. Except for China, from 2005:1-2020:12 due to the shift to a more flexible currency policy. The 'red' line is set to clarify the different key events shocks for each currency around 2008, 2015, and 2019.

Particularly, around 2015, there is a positive impact followed by a downturn around 2016 in the European countries caused by the refugees and Brexit tensions (Breinlich et al., 2020). Japan suffers a huge depreciation around 2013 until 2016 in order to induce an economic growth (Shirai, 2019). Chinese's monetary authority establish new exchange rates policies to make the CNY more stable as reflected by the worth gaining from 2014 to 2016 and stabilization by the end of 2016 (Clark, 2017 and Boyd, 2021, respectively). We see the negative impact of the COVID-19 for most of the currencies at the end of the period, except for Switzerland, although the impact occurs in a different date depending on the currency. For example, in Japan we see the impact earlier than in the Eurozone. The COVID-19 impact in China is on early stages from the other currencies. Moreover, Switzerland and China show an increasing trend behaviour during the entire sample period.

3.1. Stationarity Test

Figure 3 suggests that nominal effective exchange rates are not stationary, this provides an initial motivation to look at the log differences of the nominal effective exchange rates series. For this purpose, we carry out three Unit Root Tests: (i) The *Augmented Dickey-Fuller Test* (ADF), (ii) the *Philip-Perron Test* (PP) and (iii) the *Kwiatkowski–Phillips–Schmidt–Shin Test* (KPSS). The ADF and PP tests contrast the null hypothesis of non-stationarity of the series while the null of the KPSS test is the stationarity of the series.

Table 1. Unit Root Tests of NEERs.

Exchange rates	ADF		PP		KPSS	
	$NEER_{i,t}$	$NEERR_{i,t}$	$NEER_{i,t}$	$NEERR_{i,t}$	$NEER_{i,t}$	$NEERR_{i,t}$
AUS	-2,181	-10,733	-1,934	-11,476	1,446	0,095
CAD	-1,824	-10,313	-1,861	-12,451	1,490	0,220
CHF	-0,146	-11,083	-0,017	-15,347	4,252	0,111
CNY	-0,966	-8,167	-1,566	-14,424	3,283	0,103
EUR	-1,017	-10,430	-1,027	-11,873	3,334	0,088
JPY	-2,579	-8,924	-2,378	-11,846	0,246	0,047
UK	-1,676	-10,340	-1,369	-10,215	0,934	0,148

Note. $NEER_{i,t}$ refers to the nominal effective exchange rates and $NEERR_{i,t}$ to the nominal effective exchange rates returns. This table shows the Augmented Dickey and Fuller (ADF), Philips Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests. The number of lags in the ADF test is determined following the Akaike Information Criteria. The critical values at 1%, 5% and 10% significance level of Mackinnon (1991) for the ADF and PP tests (process with intercept but without trend) are −3.43, −2.86 and −2.56, respectively. The critical values at 1%, 5% and 10% significance level for the KPSS test (process with intercept but without trend) are 0.739, 0.463 and 0.347, respectively.

According to the results in Table 1 we conclude that NEERs series are not stationary, while the log difference of the series are stationary. From this point onwards, we use the nominal effective exchange rates returns. The NEERs returns (NERRs) plot can be seen in Annex 1.

3.2. Summary Statistics and Normality Distribution Contrast

We present the summary statistics of the seven nominal effective exchange rate returns in Table 2. In addition, we test the normality distribution of the variables using the *Jarque Bera Test* (JB).

Looking at these results, median and mean do not match for any NEERR, although the differences are small. The Swiss Crown shows the highest mean while only the Euro presents a negative mean. The Canadian Dollar and the Japanese Yen present the highest volatility and the Chinese Yuan shows the lowest variability, as measured by the standard deviation (SD). Note that four exchange returns (CHF, CNY, JPY and UK), are positive skewed then, they show more extreme values in the tail related to appreciations. However, the Australian Dollar, the Canadian Dollar and the Euro exhibit negative skewness, indicating that there exists an asymmetric tail extending towards more negative values (related to depreciations). According to the kurtosis, all the distributions are clearly platykurtic, with just one exception, the Australian dollar.

Finally, all the nominal effective exchange rate returns (NEERRs) are non-normally distributed, as indicated by the rejection of the Jarque-Bera test at the 1% significance level (except the Chinese Yen, for which the normal distribution is rejected at the 10% significance level).

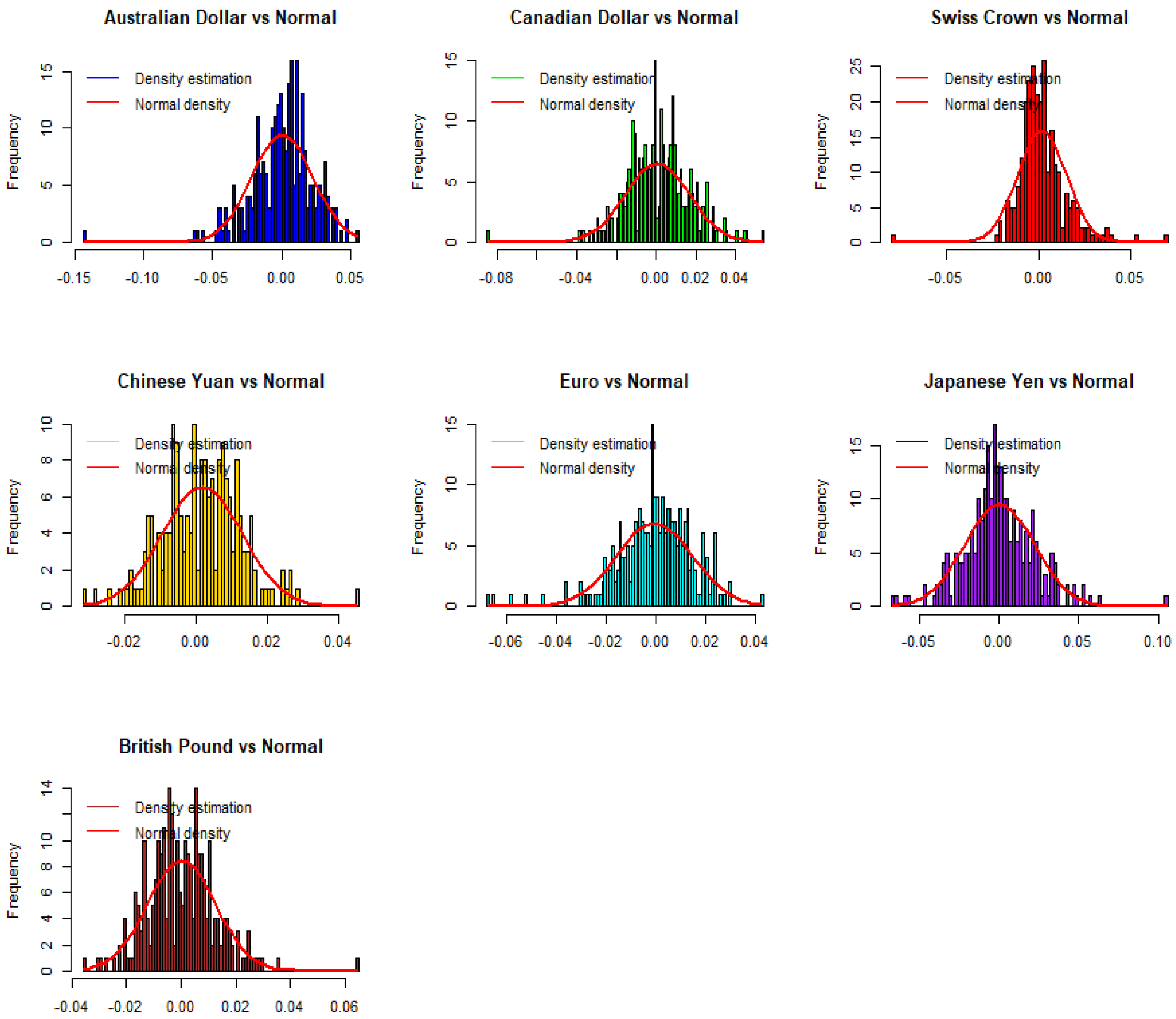
Figure 4 confirms the results obtained in Table 2. Even though, mean and median differences are not visually appreciable, it is clear that the Swiss Crown, Chinese Yuan, Japanese Yen and British Pound are positive skewed while the Australian Dollar, Canadian Dollar and Euro are negative skewed. Annex 2 shows the QQ-plot of the nominal effective exchange rate returns in which we clearly observe tail extreme values compared to a Normal distribution.

Table 2. Summary Statistics of the NEERRs.

Exchange Rates	Median	Mean	Minimum	Maximum	SD	Skewness	Kurtosis	JB	*p*-value
AUS	0,0021	0,0004	-0,1438	0,0543	0,0167	-1,2334	2,9960	470,507	0,0000
CAD	0,0003	0,0007	-0,0845	0,0535	0,0222	-0,3274	-0,3591	83,694	0,0000
CHF	0,0002	0,0017	-0,0795	0,0694	0,0162	0,2688	-4,8756	697,332	0,0000
CNY	0,0019	0,0011	-0,0318	0,0451	0,0132	0,1330	-2,2246	5,722	0,0570
EUR	0,0001	-0,0007	-0,0677	0,0042	0,0153	-0,9476	-0.1972	128,649	0,0000
JPY	-0,0013	0,0002	-0,0670	0,1056	0,0221	0,3496	-0,9635	52,599	0,0000
UK	-0,0005	0,0002	-0,0359	0,0642	0,0124	0,5494	-0,8044	68,139	0,0000

Note. *SD* refers to standard deviation and *JB* refers to Jarque Bera. The *p*-value corresponds to the Jarque Bera test. Kurtosis refers to the excess of kurtosis.

Figure 4. Histograms of the NEERRs vs Gaussian distribution.



Note. This figure shows the histogram of the distribution of each currency. The 'red' line draws the probability distribution of a gaussian distribution.

4. Methodology

As discussed in *Section* 3, the selected nominal effective exchange rates returns (NEERRs) do not follow a Normal distribution and present heavy tails. Thus, we want to understand the impact of uncertainty on the entire distribution of these nominal effective exchange rate returns, and in particular on tail events. This is, we are interested in analysing how the probability of sharp exchange rate movements (in either direction) is affected by different types of uncertainty. We rely on quantile regression, as introduced by Koenker and Basett (1978), to model the nominal effective exchange rate returns as a function of each uncertainty index. This methodology allows to model the entire conditional distribution of a dependent variable given a set of explanatory variables, unlike standard regression, which provides an estimate of the conditional mean of a variable given these explanatory variables.

By definition, a quantile indicates the τ-infimum value such that the probability of the random variable to be lower than x is higher than that τ.

$$q_{\tau}(X) \ = \ \inf\{x|P(X \leq x) \geq \tau$$

Following the existing literature applying quantile regression, we specify a linear model for the conditional quantiles of *NEERRs* as follows:

$$Q_{\tau}(NEERR_{i,t}|X_j) = \ \alpha_{i,\tau} \ + \ \beta_{i,\tau}X_{j,t} + \varepsilon_{i,t} \tag{1}$$

where $NEERR_{i,t}$ refers to the *i-th* nominal effective exchange rate returns, X_j is the *j-th* uncertainty index measure and $\varepsilon_{i,t}$ is the error term. Function Q_{τ} computes quantiles τ[10] of the distribution of $NEERR_{i,t}$ given X_j, In this line, an estimate $\hat{\beta}_{i,\tau}$ of the unknown coefficient for the τth quantile, is obtained by minimizing the following equation:

$$\hat{\alpha}_{\tau}, \hat{\beta}_{\tau} \ = \ argmin \ \sum_{i=1}^{n} \rho_{\tau} \left(NEERR_{i,t} - \alpha_{\tau} \ - \beta_{\tau}X_{j,t}\right) \tag{2}$$

[10] We define our quantile distribution levels τ as the entire distribution but we present the results for the $\tau_{lower} = \{1\%, 5\%, 10\%\}$, the median $\tau = 50\%$ and the $\tau_{upper} = \{90\%, 95\%, 99\%\}$.

where $\rho_\tau(\cdot)$ is a loss function, given by $\rho_\tau(\varepsilon) = (1-\tau)I_{\{\varepsilon<0\}}|\varepsilon| + \tau I_{\{\varepsilon>0\}}|\varepsilon|$, with $I_{\{\varepsilon<0\}}$ taking the value of 1 when the subscript is true and 0 otherwise. The mathematical formulation in equation (2) leads to the solution of a linear programming optimization problem (see Koenker, 2005 for further details). In order to be able to compare the magnitude of the effects across different exchange rates, all the variables were normalized to have zero mean and unitary variance.

In *Section* 5 we present and discuss the obtained results. For ease of interpretation, we adopt the convention that the left (right) tail of NEERRs represents depreciations (appreciations). Table 3 provides a scheme of how the estimation results are interpreted.

Table 3. Quantile regression model results interpretation.

	Left Tail	**Right Tail**
Positive Value	∇ Risk of sharp depreciation	Δ Probability of appreciation
Negative Value	Δ Risk of sharp depreciation	∇ Probability of appreciation

5. Results of Quantile Regression Model

To examine how the exchange rates move when the uncertainty level changes and considering the idiosyncratic components of each currency, we estimate the model equation (1) on a currency-by-currency basis for a panel of the selected countries and uncertainty indexes from 1999:01 to 2020:12[11]. We consider the nominal effective exchange rates returns (NEERRs) to identify the different effects on the currencies, avoiding potentially biased estimations by the US Dollar as the reference currency which could be affected by the US uncertainty conditions.

The tables shown in this section present the results from the estimation of model equation (1) in the selected quantiles $\tau \in \{0.01, 0.05, 0.10, 0.50, 0.90, 0.95, 0.99\}$. Table 4A displays the effects of the four news-based uncertainty indexes, while Table 4B shows the effects of the two econometric uncertainty indexes.

The global evidence on the impact of news-based uncertainty indexes over the nominal effective exchange rates returns (see Table 4A) suggests four major points: (i) an increase in uncertainty reduces both the probability of sharp appreciation and the risk of sharp depreciation, as right (left) tail presents negative (positive) values; (ii) the effects of the Economic Policy Uncertainty (EPU) index are opposite to those of the other news-based indexes; (iii) there is scarce evidence of effects in the median for all the currencies and uncertainty measures; (iv) some currencies exhibit minor effects across the distribution even null for some uncertainty indexes. We explore this idea in this section, which suggests that these currencies perform as safe haven currencies when the uncertainty rise through monetary and trade policies. Moreover, the intensity of the uncertainty effects differ among countries and indexes highlighting the asymmetry among currencies and uncertainty indexes.

Table 4A, Panel A shows that the currencies exhibit low sensitivity to the uncertainty associated to changes in the Monetary Policy (MPU). Only the nominal effective exchange rates returns of the Asiatic currencies, the Euro and the Australian Dollar react in one tail to the MPU index. An increase in the MPU index reduces the probability of appreciation of the Australian Dollar and Chinese Yuan, as well as the

[11] As described in *Section* 2 the Chinese Yuan period goes from 2005:01 to 2020:12.

risk of sharp depreciation of the Japanese Yen . The Euro and the Japanese Yen are the only currencies that exhibit significative results in the median.

As expected, the nominal effective exchange rates returns sensitivity is higher to the Trade Policy Uncertainty index (see Table 4A, Panel B). An increase of the Trade Policy Uncertainty (TPU) index reduces the risk of a sharp depreciation of the Australian Dollar, Euro, Japanese Yen and British Pound and, also, reduces the probability of appreciation of the Australian Dollar and Canadian Dollar . The Chinese Yuan exhibits negative results in the median and both tails, this is, an increase in the Trade Policy Uncertainty induces a rise in the risk of sharp depreciation, as the results are negative.

Panel C in Table 4A, shows the sensitivity of the nominal effective exchange rates returns to the geopolitical tensions (GPR). The Australian Dollar, Japanese Yen and British Pound show significative coefficients in both tails. Left (right) tail coefficients are positive (negative) signalling that the risk (probabilities) of sharp depreciation (appreciation) decreases when the geopolitical tensions increase. The Euro exhibits similar results in the right tail and it is the only which shows an impact in the median.

Table 4A, Panel D displays the effects of the economic uncertainty (EPU) index on the nominal effective exchange rates returns. The evidence is opposite to the other news-based uncertainty indexes. We highlight that now all the currencies react against the economic uncertainty variations, even the Swiss Crown. In this case, an increase in the economic uncertainty induces a rise in the risk of sharp depreciation of the Australian Dollar, Canadian Dollar and Euro and a rise of the probability of appreciation of the Swiss Crown, Chinese Yuan, Japanese Yen and British Pound. Moreover, only the Swiss Crown exhibit an impact in the median.

Figure 5 shows the graphical representation of the response of the nominal effective exchange rates returns to variations in the news-based uncertainty indexes. It is possible to observe the asymmetry among the currencies and uncertainty indexes.

Table 4A. News-based uncertainty indexes.

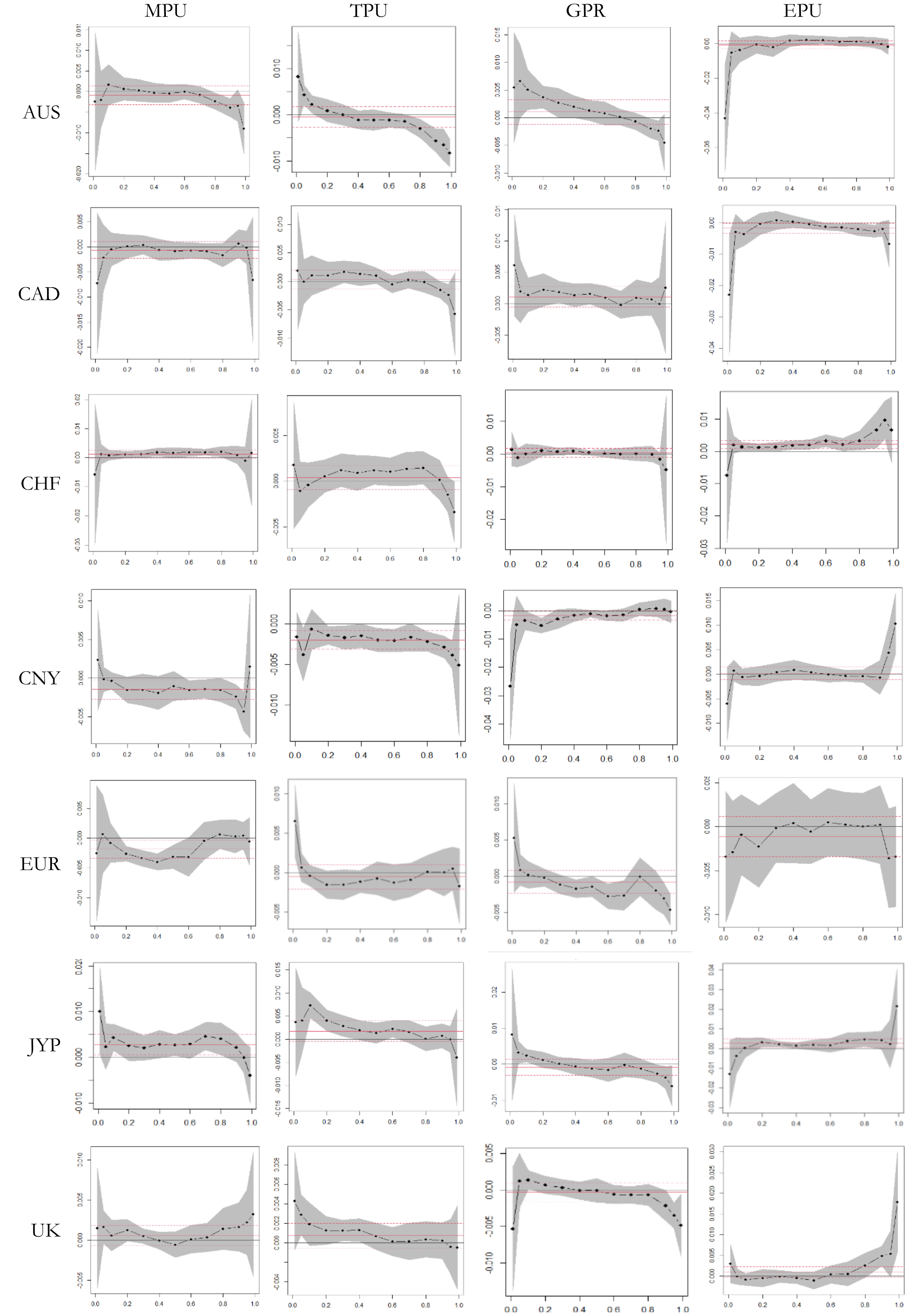
Quantiles	Nominal Effective Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
PANEL A: Monetary Policy Uncertainty index (MPU)							
0.01	-2.41	-7.21	-5.74	2.32	-2.5	**10.10***	1.50
0.05	-1.99	-2.12	1.22	-0.19	0.71	2.35	1.64
0.1	1.69	-0.49	0.83	-0.38	-0.78	**4.36*****	0.58
0.5	-0.44	-0.79	1.70	-1.06	**-3.13****	**2.70***	-0.56
0.90	**-3.89****	0.71	0.96	**-2.41*****	0.32	2.18	1.63
0.95	-3.41	-0.09	-0.95	**-4.33*****	0.46	-0.02	2.23
0.99	**-8.98*****	-6.57	1.72	1.47	-0.52	-3.9	3.23
PANEL B: Trade Policy Uncertainty index (TPU)							
0.01	**8.29***	1.86	1.79	-1.58	**6.53*****	3.71	4.30
0.05	**4.33****	-0.07	-1.08	**-3.78****	0.65	4.07	**2.88****
0.1	**2.26***	1.03	-0.42	-0.63	-0.39	**7.33*****	1.92
0.5	-1.15	0.98	1.20	**-1.98****	-0.73	1.36	0.67
0.90	**-5.63*****	**-1.54***	0.15	**-2.85*****	0.03	0.72	0.22
0.95	**-6.49*****	-2.42	-1.48	**-3.82*****	0.51	-0.02	-0.41
0.99	**-8.31*****	-5.75	-3.39	**-5.11*****	-1.70	-3.94	-0.49
PANEL C: Geopolitical Risk index (GPR)							
0.01	5.48	**6.10****	1.36	**-3.42*****	5.28	8.24	-5.31
0.05	**6.64***	1.96	-1.09	-2.92	0.87	**3.29***	1.27
0.1	**5.07****	1.37	0	-0.92	0.19	**2.42***	**1.38****
0.5	1.32	1.54	0.35	-0.57	**-1.43***	-1.23	-0.05
0.90	**-1.94***	0.67	-0.1	0.23	-1.93	-2.63	-2.13
0.95	**-2.34***	-0.05	-1.65	-3.6	**-3.05*****	**-3.68****	**-3.48*****
0.99	**-4.47***	2.52	-4.85	-3.41	**-4.59*****	**-6.03****	**-4.83****
PANEL D: Economic Policy Uncertainty index (EPU)							
0.01	**-43.10****	**-22.90***	-7.36	-6.02	**-26.50****	-12.9	3.04
0.05	-5.13	-2.84	2.09	0.69	-5.02	-3.72	-5.64
0.1	-3.68	-3.52	**1.41****	-0.6	**-3.45***	0.34	-0.82
0.5	2.08	-0.35	**2.10****	0.4	-1.09	1.88	-1.02
0.90	0.67	-2.58	**6.64****	-0.7	0.65	4.31	**4.86*****
0.95	-0.24	-1.87	**9.73*****	4.38	0.47	2.38	**5.44***
0.99	-1.8	**-6.62****	6.65	**10.30*****	-0.38	**21.60***	**17.90****

Note. We use the NEERRs abbreviation introduced in *Section 2*. Quantile stands for the three most representative regions of the distribution: both tails and median for the period from 1999:01 to 2020:12, except China (2005:01-2020:12). NEERRs are the independent variable and the value in cells represents the response against changes in the uncertainty measure at quantile tau $(\beta_{i,\tau})$ multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10$ % levels, respectively. Standard errors are based on bootstrap with 1000 replications.

In line with the results provided in Table 4A, Figure 5 shows that the effects of the EPU index are widely different from the other news-based uncertainty indexes. If we focus on the MPU, TPU, and GPR uncertainty indexes, generally all currencies tend to shift from positive effects in the lowest quantiles to negative ones in the highest quantile. However, we observe some patterns among currencies that should be highlighted since they confirm the different effect of the uncertainty even when it is measured by the same criteria. For instance, when the MPU index changes, only the Canadian Dollar and Euro exhibit a risky behaviour as present negative values in the left tail, while the remaining currencies stablish safer behaviour. In the case of the TPU index, all the currencies shift, generally, from positive to negative values in the upper quantiles, and particularly, the Swiss Crown, Chinese Yuan and Euro drops sharply in the second quantile ($\tau = 0.05$) to negative values. This means, that an increase in the uncertainty of the US trade policy makes these three currencies initially weaker. This makes sense as the US Dollar is considered as a reserve currency, so since a huge percentage of the international trade is done in dollars, most of the countries hold US dollar reserves to ensure the international trades (see Siripurapu, 2020), then there is a generalised loss of currency power for all the currencies, as they do not appreciate. Regarding to the GPR index, we observe high significance in all currencies, except for the Swiss Crown. The Chinese Yuan is the riskiest currency when assessing the US geopolitical tensions. This is caused by trade war and political tensions between these countries. The remaining currencies seems to be safe against this uncertainty measure.

In the case of the EPU index, we highlight that the Swiss Crown remain with a similar dynamic to the others three uncertainty indexes. As well, we highlight the shift turnover from the Australian Dollar, Chinese Yuan, Japanese Yen and British Pound, as for the EPU these currencies now shift from negative to positive values. The Canadian Dollar is very similar to the Australian Dollar when assessing the EPU, and very similar to the MPU impact. Figure 5 displays that generally, even measured with different types of uncertainty, the Swiss Crown or Japanese Yen act as safer currencies, while others, such as the Australian Dollar are considered risky currencies. These evidences support the results found in Ranaldo and Soderling (2010).

Figure 5. News-based uncertainty indexes.



Note. The linear effect is indicated by the solid red line accompanied by two parallel dotted lines, representing the 95% confidence intervals of the regression. The effects of uncertainty indexes under different quantiles of the NEERRs are captured by the dash-dotted black line accompanied by the associated bootstrapping confidence intervals of the quantile regression (gray-shaded area).

We follow with the analysis of the econometric uncertainty indexes impact on the NEERRs, reported in Table 4B. In comparison with news-based uncertainty indexes effects (Table 4A), we observe larger evidence on the effects on NEERRs from changes in the uncertainty approached by econometric indexes, being these effects similar to the observed in the EPU (see panel D in Table 4A). Moreover, we highlight the low impact of these indexes in the Canadian Dollar and the Swiss Crown, even the Macroeconomic Uncertainty impact is null for the Swiss Crown. These results confirm that the Swiss Crown can be considered as safe haven currency (Ranaldo and Soderling, 2010) no matter the uncertainty measure we use and highlight that when uncertainty is measured by news-based indexes, all the currencies exhibit more stability, such as the Euro or the British Pound, but when uncertainty is measured by econometric uncertainty, they turns more vulnerable. This means that, the sensitivity of the Euro and British Pound is more evident from the investors' expectations on the predictability of the uncertainty on the NEERRs in the financial markets compared to the policymaker framework observed in the news media.

Particularly, the impact of the US Financial uncertainty over the nominal effective exchange rates returns is shown in Table 4B, Panel A. An increase in the US Financial Uncertainty induces an increase of the risk of sharp depreciation for the Australian Dollar, Canadian Dollar, Chinese Yuan and Euro. In contrast, the Australian Dollar, Swiss Crown, Chinese Yuan, Japanese Yen and British Pound reacts to US Financial Uncertainty with an increase in the probability of appreciation. The response to US Macroeconomic Uncertainty (Panel B, Table 4B) is similar to the response to the US financial uncertainty (panel A). We observe that the Australian Dollar, Canadian Dollar, Euro and British Pound exhibit an increase in the risk of sharp depreciation when the US Macroeconomic Uncertainty rise, whilst the Australian Dollar, Chinese Yuan, Euro, Japanese Yen and British Pound increase the probability of sharp appreciation. There is no evidence of impact in the median for any currency.

Then the Australian Dollar, Canadian Dollar and Euro are the riskiest from the econometric perspective, while the Chinese Yuan is riskier when assessing the financial indicators and the British Pound if we analyse the Macroeconomic indicators. These results could be motivated by the financial control of the Chinese government and the Brexit results, which have affected to the distinct financial markets. Moreover, for the econometric indexes, the Japanese Yen and Swiss Crown are safe haven currencies.

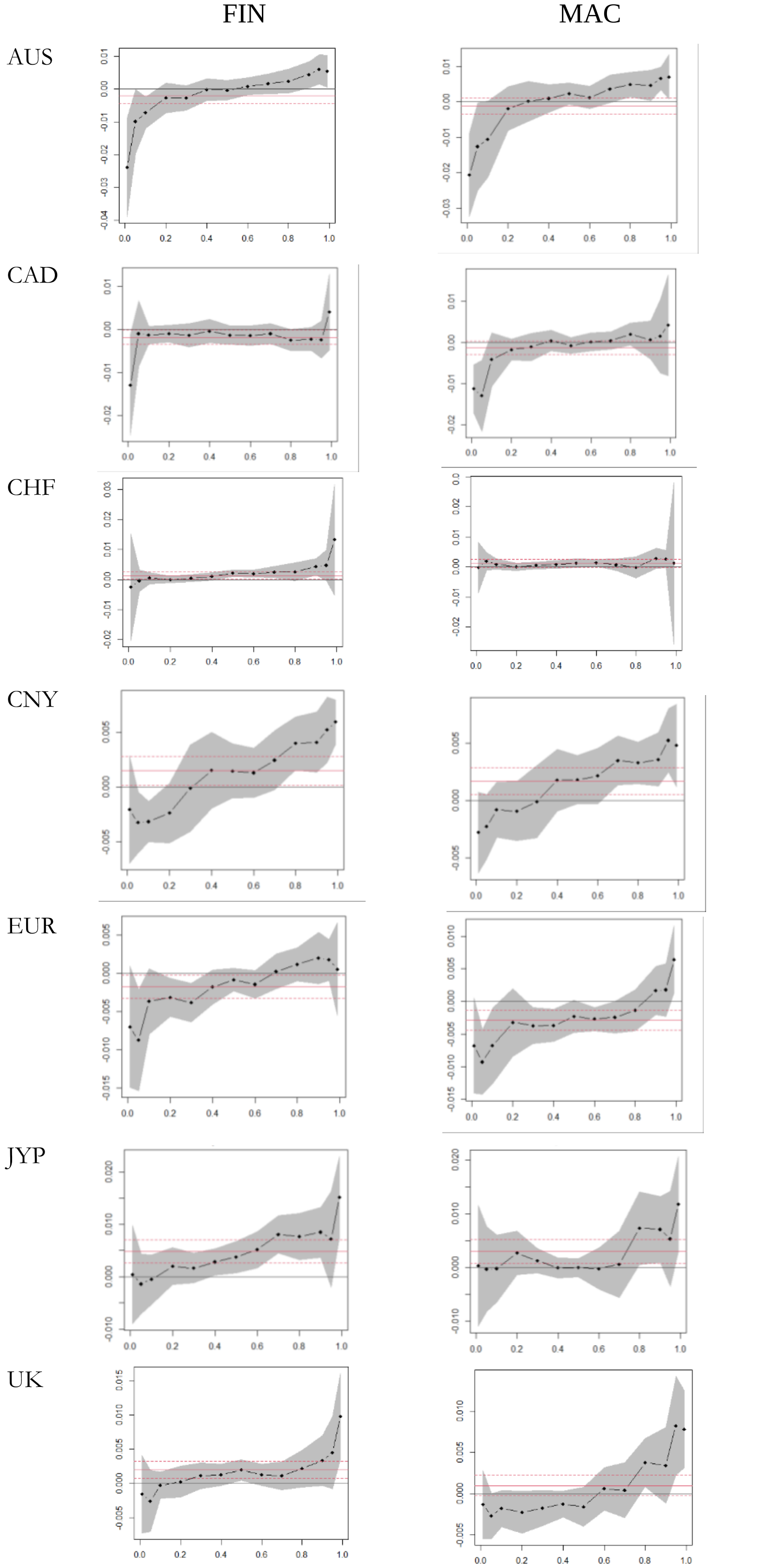
Table 4B. Econometric-based uncertainty indexes.

Quantiles	Nominal Effective Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
PANEL A: Financial Econometric index (FIN)							
0.01	**-23.9****	**-13.00***	-2.49	-2.05	7.00	0.38	-1.53
0.05	-9.90	-1.00	-0.40	**-3.25***	**-8.73****	-1.41	-2.53
0.1	**-7.15****	-1.30	0.51	**-3.16*****	-3.65	-0.52	-0.23
0.5	-0.39	-1.35	**2.14*****	1.47	-0.82	**3.75***	**1.98****
0.90	**4.41***	-2.24	**4.27****	**4.11****	2.00	**8.5*****	**3.35***
0.95	**6.02****	-2.38	4.76	**5.25*****	1.78	7.15	4.50
0.99	**5.41***	4.05	13.2	**5.95*****	0.562	**15.2*****	**9.81****
PANEL B: Macroeconomic Econometric index (MAC)							
0.01	**-20.6****	**-11.3*****	-0.23	-2.76	-6.76	-0.39	-1.35
0.05	**-12.6***	**-13.00****	1.89	-2.26	**-9.26*****	-0.28	**-2.73***
0.1	**-10.5***	-4.18	0.86	-0.80	**-6.76****	-0.16	-1.82
0.5	2.33	-0.746	1.20	1.82	-2.31	-0.01	-1.61
0.90	**4.64***	0.60	2.83	**3.59*****	1.68	**7.12****	3.40
0.95	**6.62*****	1.52	2.52	**5.24*****	1.79	5.35	**8.21****
0.99	4.16	1.19	**4.82****	**6.43****	**11.8****	**7.79****	**7,79****

Note. We use the NEERRs abbreviation introduced in *Section 2*. Quantile stands for the three most representative regions of the distribution: both tails and median for the period from 1999:01 to 2020:12, except China (2005:01-2020:12). NEERR is the independent variable and the value in cells represents the response against uncertainty measure changes at quantile tau $(\beta_{i,\tau})$ multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10$ % levels, respectively. Standard errors are based on bootstrap with 1000 replications.

Figure 6 shows the response of these currencies to changes in both econometric uncertainty indexes. We find that the effects of econometric uncertainty indexes on the nominal effective exchange rate returns are generally different from the news-based uncertainty indexes effects and tend to present higher values in the extreme quantiles. For example, the Australian Dollar and the Chinese Yuan according to the risky currencies assumptions, exhibit larger risk of sharp depreciation. The Swiss Crown and the Japanese Yen response is very close to zero in the entire distribution and the Japanese Yen exhibits positive values at the higher quantiles, corroborating consistently the safe haven assumptions.

Figure 6. Econometric-based uncertainty indexes.



Note. The linear effect is indicated by the solid red line accompanied by two parallel dotted lines, representing the 95% confidence intervals of the regression. The effects of uncertainty indexes under different quantiles of the NEERRs are captured by the dash-dotted black line accompanied by the associated bootstrapping confidence intervals of the quantile regression (gray-shaded area).

To sum up, we highlight that news-based uncertainty indexes (except from EPU) are measuring different things from econometric indexes as they exhibit widely different effects. News-based uncertainty indexes are based on the past frequency of occurrence of several uncertainty related terms in the news media, while the econometric uncertainty indexes collect the ability from a set of market variables in order to predict the economy, then there is not directly meddling from the economic agents. Likewise, we observe differences among the news-based indexes, highlighting that even collected using similar criteria, there exist certain components based on the uncertainty nature which induces to these differences. Additionally, the econometric indexes reflect the medium-term uncertainty, whilst the news-based uncertainty reflect a shorter-term behaviour. Nevertheless, both measures of uncertainty drives to an analogous conclusion: the effects in the tails are widely larger than in the median, and exhibit an asymmetric behaviour, being similar within the different uncertainty groups (except for the analogous effects of EPU to the econometric measures).

Likewise, we highlight the evidences on the differences among currencies. Overall, the Swiss Crown confirm the prevailing narrative about FX markets as this currency tends to appreciate when the uncertainty increase (either news-based or econometric) and reduces the impact in the left tail, performing as a safe haven currency, in line with Ranaldo and Soderlind (2010). The Japanese Yen is also considered as a safe haven currency, highlighting this behaviour in the econometric indexes (Eguren-Martin and Sokol, 2020), and we observe that when we assess the effects of MPU and TPU, this currency turns less stable. This assumption leans on the different policy turnovers from Japan to palliate the shocks in its economy, such as the Fukushima nuclear disaster in 2011 or the US-China Trade war since mid-2018. Then, the Japanese Yen is considered as safe currency in line with Ranaldo and Soderlind (2010) if we mainly avoid considering the idiosyncratic strong bonds to China and United States in terms of Trade[12]. Regarding to the remaining currencies, when we assess the effects of news-based indexes, we find that the Canadian Dollar, Chinese Yuan and the Euro exhibit certain stability against the MPU and TPU indexes. We see that these currencies behave riskier in the case of GPR and EPU, caused by the different economic crises. Again, we highlight the different impact within the same group of uncertainty measures.

[12] According to the World Integrated Trade Solutions (WITS) Japan exports/imports to/from, mainly, the United States and China. For further information about the Japan trade data see the website https://wits.worldbank.org/countrysnapshot/en/JPN/textview.

Moreover, when we assess the econometric uncertainty indexes, these currencies behave as risky currencies, since the shift to the extremes of the distribution in such risky uncertainty conditions is widely evident. Particularly, the Canadian Dollar and Euro tends to follow the US economy drift to hold their trade position and investment relationships with the United States (*U.S. Relations With Canada*, 2021 and *United States-Trade-European Commission*, 2021), then the US policy framework (MPU and TPU) anticipates changes in these two currencies to hold the stability with the US Dollar, although the financial markets act independently and riskier (EPU, MAC and FIN). This makes sense, as both countries major trade partner is the United States (*CIA – World Factbook*, 2021). In contrast, China tries to hold its world trade position with strong economic policies against the United States, then the US news-based uncertainty effects is less evident in the Chinese Yuan than the effects of econometric indexes. The riskiness of this currency is linked -among other factors- to the investors' expectations (EPU and FIN) and the government stance to the country-specific macroeconomic indicators (MAC). We find similar results to Chen et al. (2020), who find that the policymakers have a strong impact in the market stability. Moreover, the Chinese Yuan, the British Pound and the Australian Dollar seem to be the least safe haven currencies as they tend to behave erratically depreciating in such uncertainty conditions, as stated by Ranaldo and Soderlind (2010). Beyond that, we prove again that even measured with the same criteria, the Australian Dollar is the riskiest for the EPU and the British Pound is the riskiest for the GPR and the Chinese is riskier in these two indexes. Nevertheless, these currencies present more stability in the other news-based indexes. Furthermore, for the econometric uncertainty indexes, these currencies exhibit large significance on the risk of sharp depreciation (UK mainly for the Macroeconomic Uncertainty and CNY mainly for the Financial uncertainty) proving their risky behaviour in this context.

Figure 5 and Figure 6 capture the asymmetry of the quantile approach for the NEERRs and the advantage of this approach with respect to the OLS-based alternatives commonly used in literature, as stated by Chen et al. (2020). OLS coefficients are broadly able to capture the median behaviour of the currencies; however, much useful information is loss when only analysing the conditional mean. It is evident that a richer characterisation of conditional distribution is given by focusing on the entire conditional distribution, in line with Eguren-Martin and Sokol (2020).

5.1.Goodness of fit

We follow Koenker and Machado (1999) and report quantile-specific $R^2(\tau)$ measures for all currencies and uncertainty indexes. We define the $R^2(\tau)$ as the local measure of relative goodness of fit based on the absolute deviation of two models of conditional quantile function. We consider this measure differently to the standard R^2 which quantify the relative success of two models focusing on conditional mean function. Thus, the goodness-of-fit $R^2(\tau)$ is defined as the relative success of the quantile regression in a specific quantile (τ):

$$R^2(\tau) = 1 - \hat{V}(\tau) \,/\, \widetilde{V}(\tau) \qquad (3)$$

Where $\hat{V}(\tau)$ is the sum of weighted absolute residuals of equation (1) and $\tilde{V}(\tau)$ the sum of weighted absolute residuals of a model restricted only to a constant[13]. $R^2(\tau)$ expresses the improvement in fit by using quantile regression, in a similar way that standard R^2.

Tables 5 displays the $R^2(\tau)$ and standard R^2 measures for all currencies and uncertainty indexes: new-based indexes (Table 5A) and econometric indexes (Table 5B). Regarding the standard R^2, we highlight that the predictive ability of the different uncertainty measures on NEERRs varies across indexes. Note that these indexes collect the uncertainty from different sources. This predictive ability also varies across countries noting that the uncertainty has an idiosyncratic component based on country-specific impact.

Regarding to the $R^2(\tau)$, the most important point to remark is that, regardless of the currency, the goodness-of-fit tends to improve in the tails. It is evident the superior approach of quantile regression compared to the mean approaches. Particularly, these improvements tend to be concentrated in one tail. For the news-based uncertainty measures, this concentration is determined for each currency, although it still tends to be located in one tail, it depends on the currency. For the econometric uncertainty indexes, the improvement highlights in the right tail, except for the Australian Dollar and Canadian Dollar, in which the left tail improvement is particularly evident.

[13] $\tilde{V}(\tau)$ provides an estimate of the unconditional quantile τ.

Table 5A. Goodness of fit: News-based uncertainty indexes.

	$R^2(\tau)$							R^2
Exchange Rates	0.01	0.05	0.10	0.50	0.90	0.95	0.99	
PANEL A: Monetary Policy Uncertainty (MPU)								
AUS	0%	0%	0%	0%	**2%**	**1%**	**6%**	0%
CAD	**3%**	**1%**	0%	0%	0%	0%	**2%**	0%
CHF	**1%**	0%	0%	**1%**	0%	0%	0%	0%
CNY	**2%**	0%	0%	1%	**4%**	**6%**	0%	2%
EUR	**1%**	0%	**1%**	**2%**	0%	0%	**1%**	1%
JPY	**3%**	1%	**3%**	1%	1%	0%	**3%**	2%
UK	0%	**1%**	0%	0%	**1%**	**1%**	**1%**	0%
PANEL B: Trade Policy Uncertainty (TPU)								
AUS	**3%**	**2%**	**1%**	0%	**3%**	**3%**	**10%**	0%
CAD	**1%**	0%	0%	0%	**1%**	**1%**	**5%**	0%
CHF	**8%**	0%	0%	0%	0%	**1%**	**4%**	0%
CNY	2%	1%	1%	2%	**4%**	**7%**	**6%**	4%
EUR	**4%**	0%	0%	0%	0%	0%	**2%**	0%
JPY	**1%**	**2%**	**4%**	0%	0%	0%	**1%**	1%
UK	**5%**	**2%**	**1%**	0%	0%	0%	0%	0%
PANEL C: Geopolitical Risk index (GPR)								
AUS	**2%**	**1%**	**3%**	0%	**1%**	**2%**	**2%**	0.2%
CAD	**2%**	0%	0%	**1%**	0%	0%	0%	0.4%
CHF	**1%**	0%	0%	0%	0%	**2%**	**3%**	0.1%
CNY	**6%**	**1%**	**1%**	0%	0%	**2%**	**5%**	0.4%
EUR	**3%**	**1%**	0%	**1%**	0%	**2%**	**7%**	0.3%
JPY	0%	**1%**	**1%**	0%	**1%**	**2%**	**5%**	0.2%
UK	**1%**	**1%**	0%	0%	**1%**	**3%**	**3%**	0.1%
PANEL D: Economic Policy Uncertainty (EPU)								
AUS	**2%**	**1%**	**3%**	0%	**1%**	**2%**	**2%**	0.2%
CAD	**2%**	0%	0%	**1%**	0%	0%	0%	0.4%
CHF	**1%**	0%	0%	0%	0%	**2%**	**3%**	0.1%
CNY	**6%**	**1%**	**1%**	0%	0%	**2%**	**5%**	0.4%
EUR	**3%**	**1%**	0%	**1%**	0%	**2%**	**7%**	0.3%
JPY	0%	**1%**	**1%**	0%	**1%**	**2%**	**5%**	0.2%
UK	**1%**	**1%**	0%	0%	**1%**	**3%**	**3%**	0.1%

Note. $R^2(\tau)$ is defined in equation (3) with respect to the equation (1). $R^2$is the standard R^2 from OLS of a model consisting only of a constant. Both measures are shown in percentage, and those $R^2(\tau) \geq R^2$ are shown in bold type.

Table 5B. Goodness of fit. Econometric uncertainty indexes.

	$R^2(\tau)$							R^2
Exchange Rates	0.05	0.05	0.10	0.50	0.90	0.95	0.99	
PANEL A: Financial Econometric index (FIN)								
AUS	**31%**	**8%**	**6%**	0%	**3%**	**1%**	**10%**	1%
CAD	**23%**	0%	**1%**	0%	**1%**	**4%**	**4%**	1%
CHF	**1%**	0%	0%	**2%**	**3%**	**1%**	**2%**	1%
CNY	**5%**	**6%**	**6%**	1%	**9%**	**17%**	**37%**	2%
EUR	**8%**	**4%**	**3%**	0%	**1%**	**1%**	**1%**	1%
JPY	0%	0%	0%	1%	**8%**	**9%**	**27%**	5%
UK	**4%**	1%	0%	1%	**5%**	**8%**	**26%**	3%
PANEL B: Macroeconomic Econometric index (MAC)								
AUS	**32%**	**9%**	**5%**	0%	**4%**	**8%**	**16%**	0%
CAD	**33%**	**6%**	**3%**	0%	0%	0%	**8%**	1%
CHF	0%	0%	0%	0%	**2%**	**4%**	0%	1%
CNY	**3%**	**4%**	1%	1%	**11%**	**16%**	**27%**	3%
EUR	**10%**	**13%**	**5%**	1%	1%	1%	**11%**	3%
JPY	0%	0%	0%	0%	**7%**	**9%**	**19%**	2%
UK	**2%**	**4%**	**2%**	0%	**6%**	**9%**	**28%**	1%

Note. $R^2(\tau)$ is defined in equation (3) with respect to the equation (1). $R^2$is the standard R^2 from OLS of a model consisting only of a constant. Both measures are shown in percentage, and those $R^2(\tau) \geq R^2$ are shown in bold type.

6. Robustness Test

In this section we check the robustness of our baseline results with regard to: (i) a more stable period, (ii) bilateral exchange rates, and (iii) other uncertainty measure which proxies the stress in the financial markets. First, we consider a subsample which includes a period of more economic stability (from January 2011 to December 2019) in order to avoid biased results from crises periods, such as the subprime crisis, the sovereign debt crisis or COVID-19. Second, we use the US bilateral exchange rate returns as an alternative to the NEERRs. Last, we explore an alternative proxy measure for uncertainty based on the US financial stress conditions, named the National Financial Condition Index (NFCI) developed by the Chicago Federal Reserve (Chicago FED). We use this index as it is constructed to provide indexed information of the US financial conditions in the US financial markets (equity, debt, banking system, etc.).

6.1. Stable period

Our previous evidence showed that uncertainty has a significant impact on the NEERRs during the baseline period from 1999:01 to 2020:12. In this period of time, the uncertainty indexes oscillates over time and present the maximum values coinciding with instability periods such as the subprime crisis, sovereign crisis or COVID-19 (see Figure 1 and 2). Consequently, our results could be capturing the impact of extreme values of uncertainty on NEERRs in such periods of turbulence. In order to rule out this possibility, we proceed to deepen our research analysing if the results remain robust if we consider a period with more economic stability. Thus, we select the period from 2011:01 to 2019:12 to avoid the first decade of 21st century financial crises and COVID-19. With this caveat in mind, we check the robustness of the previous results from the model equation (1) to this subsample period. In Annex 3 and 4 we show complementary features regarding to the summary statistics of the new subsampled NEERRs.

Table 6A. News-based uncertainty index. Subsample from 2011:01 – 2019:12.

Quantiles	Nominal Effective Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
PANEL A: Monetary Policy Uncertainty index (MPU)							
0.01	-7.42	**-10.30*** **	**-38.30***	0.64	-12,00	**12.40** **	2.22
0.05	1.8	-8.23	2.63	-0.64	-9.80	**7.66** **	1.22
0.1	1.61	-1,00	1.10	**-1.57** **	-4.55	**6.68*** **	**2.63***
0.5	-0.89	0.80	1.13	-1.16	**-3.66***	**3.88***	-0.74
0.90	-2.75	-0.84	0.53	**-1.89** **	1.59	**4.17** **	1.56
0.95	-1.50	-2.51	-0.41	**-3.25** **	2.78	2.79	2.20
0.99	-7.51	11.70	16.00	4.01	1.53	**6.80** **	**5.80*** **
PANEL B: Trade Policy Uncertainty index (TPU)							
0.01	**5.50*** **	1.75	**11.40***	**-3.81** **	5.70	5.71	**3.17***
0.05	**2.97***	0.21	-1.00	-0.83	0.20	**10.20** **	1.13
0.1	**1.92***	1,00	-0.44	-1.31	-0.61	**7.43*** **	1.85
0.5	-0.65	1.83	1.17	**-1.98** **	-1.20	1.36	0.38
0.90	**-3.92** **	-0.78	0.28	**-2.56** **	1.60	1.47	0.14
0.95	**-5.49*** **	-1.65	-0.28	**-3.27*** **	1.29	0.72	-0.41
0.99	-7.74	-4.58	**-5.60***	**-4.93*** **	0.86	-1.21	-2.95
PANEL C: Geopolitical Risk index (GPR)							
0.01	**15.50*** **	-0.36	**25.30***	**-10.00*** **	14.7	-32.1	-3.73
0.05	**8.20** **	-2.26	-0.14	**-11.10*** **	0.80	2.11	1.34
0.1	5.93	-4.14	-2.97	-4.09	-2.42	7.21	2.6
0.5	-3.49	1.93	-1.07	-1.72	-2.07	-1.3	-1.03
0.90	**-9.60*** **	-2.81	-0.20	0.41	2.80	-2.45	-0.82
0.95	**-11.90** **	-4.66	-3.55	2.77	0.94	1.92	-1.68
0.99	-15.5	**-10.40*** **	14.6	-3.41	-3.84	-0.66	-5.43
PANEL D: Economic Policy Uncertainty index (EPU)							
0.01	-3.29	-0.62	**-34.20***	-11.2	1.53	-1.15	-1.32
0.05	1.53	-2.67	2.65	-0.38	-5.65	7.87	-0.61
0.1	1.48	-1.84	2.01	-0.98	-3.48	**5.18** **	**-2.69** **
0.5	2.93	0.27	1.40	0.01	**-2.67** **	0.84	-1.99
0.90	2.16	-1.6	1.45	-0.44	1.20	**3.56***	**3.42***
0.95	**7.66** **	-1.26	0.75	-1.06	-0.34	3.37	**3.54***
0.99	1.06	**-5.48*** **	-6.99	4.08	0.77	-1.17	3.15

Note. We use the NEERRs abbreviation introduced in *Section 2*. Quantile stands for the three most representative regions of the distribution: both tails and median for the more stable period from 2011:01 to 2019:12. NEERR is the independent variable and the value in cells represents the response against uncertainty measure changes at quantile tau $(\beta_{i,\tau})$ multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10$ % levels, respectively. Standard errors are based on bootstrap with 1000 replications.

Table 6B. Econometric uncertainty indexes, subsample from 2011:01 – 2019:12.

Quantiles	Nominal Effective Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
PANEL A: Financial Econometric index (FIN)							
0.01	-14.70	0.38	**-26.40***	2.74	**24.00***	**33.90*****	-0.36
0.05	3.06	-1.49	-5.37	-0.79	1.39	**18.10****	-2.58
0.1	6.21	-1.26	-5.45	-1.66	-0.42	**19.10*****	-0.68
0.5	-2.12	0.74	2.53	2.13	-2.94	4.65	2.29
0.90	0.32	-2.93	9.70	0.15	-2.29	6.08	5.17
0.95	3.75	-1.17	**20.20****	0.74	-4.89	8.94	5.01
0.99	14.60	-12.40	-12.30	4.34	**-6.32***	-0.63	8.46
PANEL B: Macroeconomic Econometric index (MAC)							
0.01	-6.52	**-11****	**-12.5****	4.98	11.50	16.4	-1.20
0.05	5.14	-7.76	3.25	-8.84	-12.80	6.45	**-2.32***
0.1	0.64	-10.3	0.95	0.79	1.96	4.28	**-3.24****
0.5	4.28	0.35	0.95	0.73	-1,00	-0.10	-2.76
0.90	3.66	2.10	3.07	1.34	1.68	0.92	6.85
0.95	**5.57****	0.30	3.37	0.24	-0.36	3.86	**7.82***
0.99	3.24	**-5.02*****	42.50	1.86	-2.06	-0.48	3.67

Note. We use the NEERRs abbreviation introduced in *Section 2*. Quantile stands for the three most representative regions of the distribution: both tails and median for the more stable period from 2011:01 to 2019:12. NEERR is the independent variable and the value in cells represents the response against uncertainty measure changes at quantile tau $(\beta_{i,\tau})$ multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10$ % levels, respectively. Standard errors are based on bootstrap with 1000 replications.

Tables 6A and 6B report the results of estimating equation (1) for the new subsampled period. Generally, we find robust results to the original study; nevertheless, there exist some important results to highlight. Specifically, Table 6A shows the news-based uncertainty indexes effects while Table 6B shows the econometric uncertainty indexes effects. There is evidence on the asymmetric results depending on the uncertainty measure and currency as occurred in the baseline study, nevertheless the impact is softer than the original results as now there are less significant coefficients, notoriously for the GPR, FIN and MAC. This evidence suggests that the different unstable periods, subject to higher uncertainty, lead to a huge impact on the currency behaviour; even though, in this subsample the uncertainty still plays the same role.

The results also point out that there are currencies which behave as safer currencies in unstable periods, for example the Swiss Crown,; while there are currencies which do not react to uncertainty in calm periods but react erratically in unstable periods, as the Euro or the Australian Dollar. Moreover, the Chinese Yuan exhibits a rise in the risk of sharp depreciation and, decreases the probability of appreciation, then its confirmed the risky behaviour of this currency even in calm periods when we evaluate the news-based uncertainty.

It is important to highlight the results in Table 6B as the only currencies showing significant coefficients are the Swiss Crown, Euro and Japanese Yen for the Financial Uncertainty index, indicating a decrease in the risk of sharp depreciation for the Euro and Japanese Yen, and a reduction of the probability of appreciation for the Euro (opposite to the Swiss Crown). The Macroeconomic Uncertainty index increases the risk of sharp depreciation for the Canadian Dollar, Swiss Crown and British Pound. Moreover, for the Australian Dollar and British Pound the probability of sharp appreciation increases and for the Canadian Dollar decreases. These results suggest that in periods of instability, some currencies act as safe haven currencies to create a hedge position, such as the Swiss Crown. In contrast, in the case of periods of stability, there are better currencies to invest in, despite the risk they exhibit, for example the British Pound or the Australian Dollar. These results contrast with the evidence found in Ranaldo and Soderlind (2010). Nevertheless, our subsampled period starts in 2011 while these authors evaluate the currencies until 2008. This fact could vary the consistency of the results; however, we find within this subsample period general similarities with the baseline results.

6.2. Bilateral exchange rate

Our baseline results showed that uncertainty has significant impact on the NEERRs avoiding the US-driven implications on the bilateral exchange rates. However, in order to facilitate the comparison with other papers from the literature, such as the Eguren-Martin and Sokol (2020), we consider the bilateral exchange rates and the same quantile regression model to compare the tail effects. The bilateral exchange rate returns are also not normally distributed and exhibit negative skewed coefficients (see Annex 5 and 6).

Table 7A. News-based uncertainty indexes. Bilateral exchange rates

Quantiles	Bilateral Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
PANEL A: Monetary Policy Uncertainty index (MPU)							
0.01	64.30	-49.30	-54.50	-231.00	59.40	52.80	-8.31
0.05	19.00	-36.60	**-36.10****	35.80	49.50	51.10	-8.83
0.1	8.90	-0.61	**-36.00*****	**26.90*****	**31.70*****	**40.10*****	7.64
0.5	-3.68	3.25	-0.32	-0.63	3.80	10.20	-12.00
0.90	**-34.2*****	**-17.90***	9.70	-7.22	**-32.90***	-0.33	**-2.97*****
0.95	**-47.70****	-12.20	11.60	-15.90	-3.86	-17.50	**-48.70*****
0.99	**-54.60***	-60.40	-10.80	**-55.10****	-46.00	**-52.20*****	-46.50
PANEL B: Trade Policy Uncertainty index (TPU)							
0.01	**57.20****	25.80	**-47.50****	38.90	**81.40*****	24.50	**67.80*****
0.05	**16.40***	16.20	**-32.30****	19.20	**45.60*****	43.50	23.00
0.1	**18.60*****	10.60	**-39.40*****	11.40	**28.30****	27.10	9.50
0.5	**-17.50*****	-1.0	**-11.80***	-7.00	-7.80	-5.80	**-15.60***
0.90	**-32.60*****	**-23.50****	-2.70	**-20.20***	**-26.00***	**-13.90***	**-34.00*****
0.95	**-40.80*****	**-24.10****	10.20	-12.90	-35.60	**-27.90*****	**-43.80***
0.99	**-53.70*****	-40.80	-15.50	**-39.70****	**-67.80***	**-55.30****	**-77.60***
PANEL C: Geopolitical Risk index (GPR)							
0.01	**61.00****	59.50	**-132.00*****	31.40	66.70	67.60	51.40
0.05	**26.80****	**32.60***	**-84.50*****	-6.40	35.70	23.90	19.50
0.1	**28.30*****	12.30	**-68.90****	0.80	**27.00***	14.90	9.10
0.5	3.50	**15.80****	-0.20	-24.90	4.20	-9.60	-7.60
0.90	**-14.60***	-4.10	-1.80	-29.20	-18.00	**-22.80****	-10.30
0.95	**-22.80****	-10.30	18.40	-41.30	-2.50	**-33.40*****	-25.70
0.99	-37.00	5.90	**95.20***	**-80.50****	-32.80	**-52.90*****	**-58.50****
PANEL D: Economic Policy Uncertainty index (EPU)							
0.01	**-270.00****	**-254.00****	**-174.00*****	**-307.00***	-122.00	-45.60	-20.00
0.05	-19.30	-27.90	**-64.60****	13.80	-62.20	-29.40	-48.70
0.1	-9.00	-26.80	**-43.30*****	5.40	14.70	-9.00	-16.70
0.5	12.00	0.60	0.70	0.90	9.20	13.30*	-9.80
0.90	-0.90	**-19.50***	**26.20*****	11.00	0.70	0.00	**-23.30*****
0.95	-10.20	**-17.50***	**25.20*****	36.50	-15.40	0.30	**-32.30*****
0.99	-26.10	**-47.50***	11.00	60.90	84.30	30.10	**-61.30*****

Note. We use the NEERR abbreviation introduced in *Section* 2 for the bilateral exchange rate returns. Quantile stands for the three most representative regions of the distribution: both tails and median for the original period 1999:01-2020:12, except for China. NEERR is the independent variable and the value in cells represents the response against uncertainty measure changes at quantile tau $(\beta_{i,\tau})$ multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10$ % levels, respectively. Standard errors are based on bootstrap with 1000 replications.

Table 7B. Econometric uncertainty indexes, bilateral exchange rates.

Quantiles	Nominal Effective Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
PANEL A: Financial Econometric index (FIN)							
0.01	**-141.00*** **	**-144.00** **	23.70	**-276.00** **	**-74.90** **	19.40	**-101.00** **
0.05	-69.10	-50.50	**22.60***	-50.20	**-103.00*** **	-2.50	**-78.10*** **
0.1	-32.60	-5.20	**20.70*** **	-20.70	**-45.90***	-2.40	**-76.50*** **
0.5	-1.70	-13.20	**-3.32** **	1.70	-26.50	14.90	**-34.90** **
0.90	6.20	-32.60	-5.40	23.00	**23.50***	**45.90***	-27.20
0.95	**39.70***	-10.80	-12.40	**67.70***	30.10	**64.10*** **	8.30
0.99	30.30	39.40	**-47.30***	**71.90***	**99.70** **	51.90	-2.30
PANEL B: Macroeconomic Econometric index (MAC)							
0.01	**-124.00*** **	**-126.00*** **	**40.10*** **	0.10	-165.00	16.70	**-88.00*** **
0.05	**-110.00** **	**-80.90***	**20.00*** **	-19.10	**-88.00*** **	1.90	**-88.50*** **
0.1	-72.70	-11.30	**15.00** **	-15.60	**-70.90** **	-5.80	**-76.10*** **
0.5	18.10	0.60	0.90	9.10	6.70	13.20	**-32.90** **
0.90	**32.70***	26.40	**18.60** **	11.60	30.70	**58.70** **	17.10
0.95	**39.90** **	21.60	18.20	5.90	**52.10***	**49.60** **	46.40
0.99	18.20	50.00	3.93	50.10	48.20	31.50	43.20

Note. We use the NEERRs abbreviation introduced in *Section* 2 for the bilateral exchange rate returns. Quantile stands for the three most representative regions of the distribution: both tails and median for the original period 1999:01-2020:12, except for China. NEERR is the independent variable and the value in cells represents the response against uncertainty measure changes at quantile tau ($\beta_{i,\tau}$) multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10$ % levels, respectively. Standard errors are based on bootstrap with 1000 replications.

Tables 7A and 7B report the results of quantile regression from model equation (1), where the endogenous variable is now the bilateral exchange rates returns ($r_{i,t}(\tau)$). The underlying interpretation is analogous to the NEERRs, the left (right) tail is related to the risk (probability) of sharp depreciation (appreciation). The general currency interpretation is broadly unchanged when considering bilateral exchange rates, although the bilateral exchange rates returns exhibit larger values of the effects compared to the NEERRs and some currencies present peculiarities.

The most notable difference respect to the baseline results is that now the bilateral exchange rate US/CHF is affected by all the uncertainty measures. For the news-based uncertainty indexes (see Table 7A), it exhibits negative coefficients in the left tail and the opposite in the case of econometric uncertainty indexes (see Table 7B). The underlying implication from these results is that the US/CHF bilateral exchange rate reacts sharply depending on the uncertainty measure in comparison to the NEERRs. These results point out the safe haven position of the Swiss Crown. We observe that for the Financial Uncertainty measure, as it tends to reduce the large depreciation/appreciation probabilities, and for the Macroeconomic Uncertainty measure, as all the coefficients are positive, supporting the safe haven currency assumption. In contrast, for the news-based uncertainty indexes, there is evidence of the Swiss policymakers influence on the currency control trying to keep the US/CHF stable, so the Swiss Crown does not appreciate (depreciate) sharply against the US Dollar and remain as safe haven currency. Sevil (2015) examines why the Swiss government intervention on the exchange rates policies against other currencies and explains these currency policy strategies.

A similar situation, but inversed, is shown for the Canadian Dollar, which trade and investment policy link with the US Dollar affects directly to the bilateral exchange rate with high risk of sharp depreciation for some uncertainty indexes, such as the econometric indexes or the EPU -all the related to the policymakers framework-, as shown in Table 7A. In addition, the bilateral exchange rates of US/AUS and US/UK confirm their risky behaviour, especially for the econometric indexes; and the Euro seems to be unaltered from baseline results (see Tables 7A and 7B). Lastly, the Chinese Yuan is not interpretable, as the US/CNY exchange rate leans on a controlled floating exchange rate regime. This relation between the US Dollar and the Chinese Yuan is explored more exhaustively in Chen et al. (2020).

Finally, and apart from the Swiss Crown noticeable differences, we find consistent results to the baseline study and concordantly with the findings in Ranaldo and Soderlind (2010) and Eguren-Martin and Sokol (2020) in which the Swiss Crown and the Japanese Yen are considered as safe haven currencies and the Australian Dollar as the riskiest currency.

6.3. National Financial Condition Index

To examine the robustness of our baseline results focusing on different measures of uncertainty, we propose an alternative index. Particularly, this index proxies the stability in US financial markets. Therefore, we re-estimate the quantile regression equation (1) using as explanatory variable the US financial stress, defined as the *National Financial Condition Index* (NFCI) extracted from the FRED for the original sample period (1999:01 – 2020:12) and the NEERRs. This index produced by the Federal Reserve Bank of Chicago (Chicago FED), provides a comprehensive weekly update on the "*US financial conditions in money markets, debt and equity markets and the traditional and "shadow" banking systems*". Brave and Butters (2012) exhaustively analyse this index and state that the NFCI is an indicator that predicts the financial stress over forecast horizons of up to one year. Thus, we follow the authors diagnosis of Financial Conditions and Financial Stress interpretation (see Table 8). Since the NFCI has weekly periodicity, for our analysis we aggregated the index by taking the monthly averages.

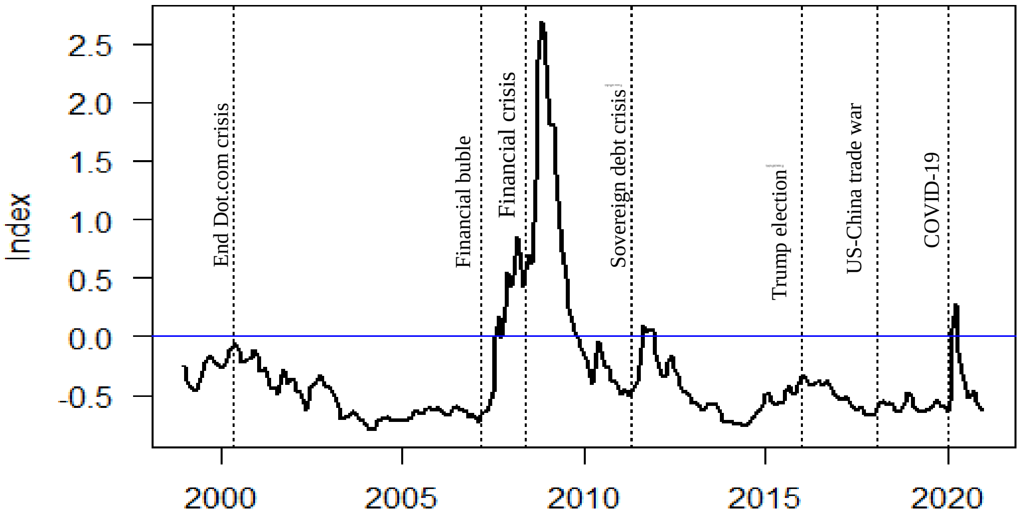
Table 8. NFCI interpretation.

	NFCI
Positive Value	Thighter-than-average
Negative Value	Looser-than-averagae

Note. This table follows the Brave and Butters (2012) interpretation of the US financial conditions given by the NFCI for the baseline period from 1999:01 to 2020:12. To avoid biased results from the estimate, we use the period from China from 2005:01 to 2020:12 due to the change into a more flexible monetary policy.

The NFCI is constructed to have an average value of zero and a standard deviation of one over a sample period from 1971. Figure 7 shows the NFCI evolution since 1999:01 to 2020:12. We observe the NFCI oscillates mostly on negative values, then the US financial conditions are generally looser-than-average. Only, for the 2007-2010 period exhibits a rapidly growth caused by the decision of diminishing the interest rate by the FRED, and posterior financial crisis. Moreover, by the beginning of 2020 there is a spike and the NFCI turns positive but very close to 0 and ends converging to previous-to-spike negative values, may be caused by the COVID-19 pandemic crisis.

Figure 7. National Financial Condition Index (NFCI) dynamics.



Note. We show the NFCI developed by the Chicago FED for the period from 1999:01 to 2020:12. The blue line is the theoretical mean at zero.

The NFCI impact over the NEERRs is reported in Table 9. Three results can be highlighted. First, the left (right) tail coefficients are negative (positive) for all currencies but only significative for three (four) currencies. An increase in financial instability increase both the risk of depreciation and the probability of appreciation, inducing a shift in the extremes of the distribution. Second, we find that generally, the currencies act as more stable currencies with respect to the financial stability changes, except for the Canadian Dollar and Euro. These two currencies, seem to be the riskier when the US financial stress rises. Third, the hedge currencies (CNY, JPY and UK) exhibit a shift towards positive values. Only the Canadian Dollar and the Euro are significative in the median. The Swiss Crown does not react to an increase in the financial stress.

Therefore, the results are generally consistent with the findings in the previous analysis, although we find some particularities. On the one hand, now the British Pound and the Chinese Yuan stablish a strong investment alternative, as they tend to appreciate sharply during the periods of increased US financial stress, alongside the Swiss Crown and the Japanese Yen, which already behaved as safe haven currencies in our baseline study. On the other hand, the Canadian Dollar is now a riskier currency as the risk of sharp depreciation increase with the rise of the US financial stress, alike the Euro and the Australian Dollar.

Then, this new uncertainty proxy could be considered as a variable influenced by a combination of the policy and investment frameworks, as the currencies present similar patterns to the news-based and econometric uncertainty indexes. Moreover, these results confirm that the Swiss Crown and the Japanese Yen are generally, safe haven currencies. The Australian Dollar is, generally, the riskiest currency, in line with the studies of Ranaldo and Soderlind (2010) and Habib and Stracca (2012). The four remaining currencies (CAD, CNY, EUR and UK) exhibit a risky/hedging behaviour depending on the type of uncertainty considered and the selected period and we highlight the better investment alternative of the Chinese Yuan, Japanese Yen and British Pound when the US financial conditions worsen.

Table 9. National Financial Condition Index.

Quantiles	Nominal Effective Exchange Rates returns						
	AUS	CAD	CHF	CNY	EUR	JPY	UK
0.01	**-30.60*** **	**-16.40*** **	-5.83	-4.60	-12.60	0.69	-2.27
0.05	**-35.60*** **	**-19.60*** **	-0.55	-4.11	**-15.10*** **	-6.55	-4.73
0.1	**-27.40*** **	-8.03	1.01	-4.81	**-16.80*** **	-1.22	-2.01
0.5	-2.49	**-7.06** **	3.13	3.08	**-6.92** **	16.70	3.96
0.90	11.10	-1.15	5.37	**6.31*** **	3.07	**26.60*** **	**15.60*** **
0.95	**16.20*** **	-0.17	10.10	**8.86*** **	3.16	**23.60*** **	**14.60*** **
0.99	**12.00*** **	12.90	26.80	**12.10*** **	**14.20* **	**30.80*** **	**16.20*** **

Note. We use the NEERRs abbreviation introduced in *Section* 2. Quantile stands for the three most representative regions of the distribution: both tails and median for the original period 1999:01-2020:12, except for China. NEERR is the independent variable and the value in cells represents the response against uncertainty measure changes at quantile tau $(\beta_{i,\tau})$ multiplied by 1000. ***, **, * indicates the significance at $\alpha = 1, 5, 10\,\%$ levels, respectively. Standard errors are based on bootstrap with 1000 replications.

7. Conclusion

Nowadays, there is a growing interest in the research of the effects of uncertainty on the economy and financial markets. There is consensus about the different impact of the uncertainty based on the different uncertainty nature (see, for example, Baker et al., 2016; or Ludvigson et al., 2019). In this line, the prevailing narrative have proposed many variables which collect and classify the uncertainty depending on the uncertainty sources and method of calculation, such as Casaldi-Garcia et al. (2020). So, in this context, this paper analyse the impact of a broad set of uncertainty measures on the foreign exchange rate market. Moreover, we try to shed light on the different effects of uncertainty depending on its nature and the country-specific fundamentals.

Some authors have addressed the effects of uncertainty on exchange rates (see, for example, Londono et al., 2019; and Krol, 2014). Nevertheless, most of them focus on the conditional mean and none address the analysis of uncertainty on the entire distribution of exchange rates. Only a few papers focus on the entire distribution to study the asymmetric effects on exchange rates, such as Eguren-Martin and Sokol (2020). Thus, in our paper, we use quantile regression to analyse the asymmetric effects of the different uncertainty measures classified in news-based and econometric measures on the nominal effective exchange rate returns during the last 22 years for a sample of currencies consisting of 7 major currencies: Australian Dollar (AUS), Canadian Dollar (CAD), Swiss Crown (CHF), Chinese Yuan (CNY), Euro (EUR), Japanese Yen (JPY) and British Pound (UK). The nominal effective exchange rates election resides in the possible biased results as we use the US uncertainty.

Mainly, the contributions of this paper are: First, we show how quantile regression is superior to capture the asymmetry on the appreciation and depreciation probabilities when assessing the effects of uncertainty on exchange rates. We also show that the effects of uncertainty is higher in the tails of the distribution than in the mean. Second, this paper shows that some currencies behave as safe haven and risky currencies, even we highlight that in unstable periods the safe haven currencies strengthened its safe haven properties. As stated in previous literature, we prove that the Swiss Crown and the Japanese Yen behave as safe haven currencies. The Euro, and Canadian Dollar follow a similar behaviour but softer as their riskiness depends on the different uncertainty measures. The Australian Dollar is shown to be the riskiest currency, followed by the British Pound and the Chinese Yuan. These currencies present more riskiness when they are evaluated with the econometric uncertainty. Third, we show that, in general, the effects of news-based indexes and econometric measures on exchange rates are different (the only exception is EPU index, which effects are similar to those of econometric measures). In addition, the impact of econometric uncertainty is larger than the news-based uncertainty. It is important to highlight, however, that country-specific conditions are widely relevant. Thus, from a policymaker and investors standpoint it is crucial to understand which type of uncertainty affects the different currencies in order to not underestimate the uncertainty impact in their investment/policy strategies.

These results are robust in several dimensions. First, when we consider a more stable period in which the uncertainty level is lower. Second, when we consider the bilateral exchange rates respect to the US Dollar. Although they could be biased as we use the US uncertainty, we find large similarities with the baseline currencies behaviour. The most notable difference appears in the US/CHF exchange rate, in which the policy framework plays a pivotal role to keep the Swiss Crown stable. Third, when we use an US uncertainty measure based on the financial stress, named, the National Financial Condition Index. Although there exist some peculiarities among some currencies within these robustness tests, the results are generally consistent and confirm the prevailing literature about hedge/safe currencies proposed by Eguren-Martin and Sokol (2020) and Ranaldo and Soderlind (2010), even using different periods from these authors. Furthermore, these currency peculiarities point out to what we confirm in this paper: the uncertainty needs to be analysed individually for each currency and period, as not all affects the same manner.

We consider we have stablished a good starting point for new comprehensive literature on the impact of the different types of uncertainty on exchange rates. A greater challenge is to focus on other groups of currencies, markets and uncertainty indexes in order to contribute to these evidences on the different uncertainty impact based on the country-specific conditions and uncertainty nature. Similarly, we expect that this paper helps to make the exchange rates dynamics more understandable for the economic agents in terms of the predictability.

8. References

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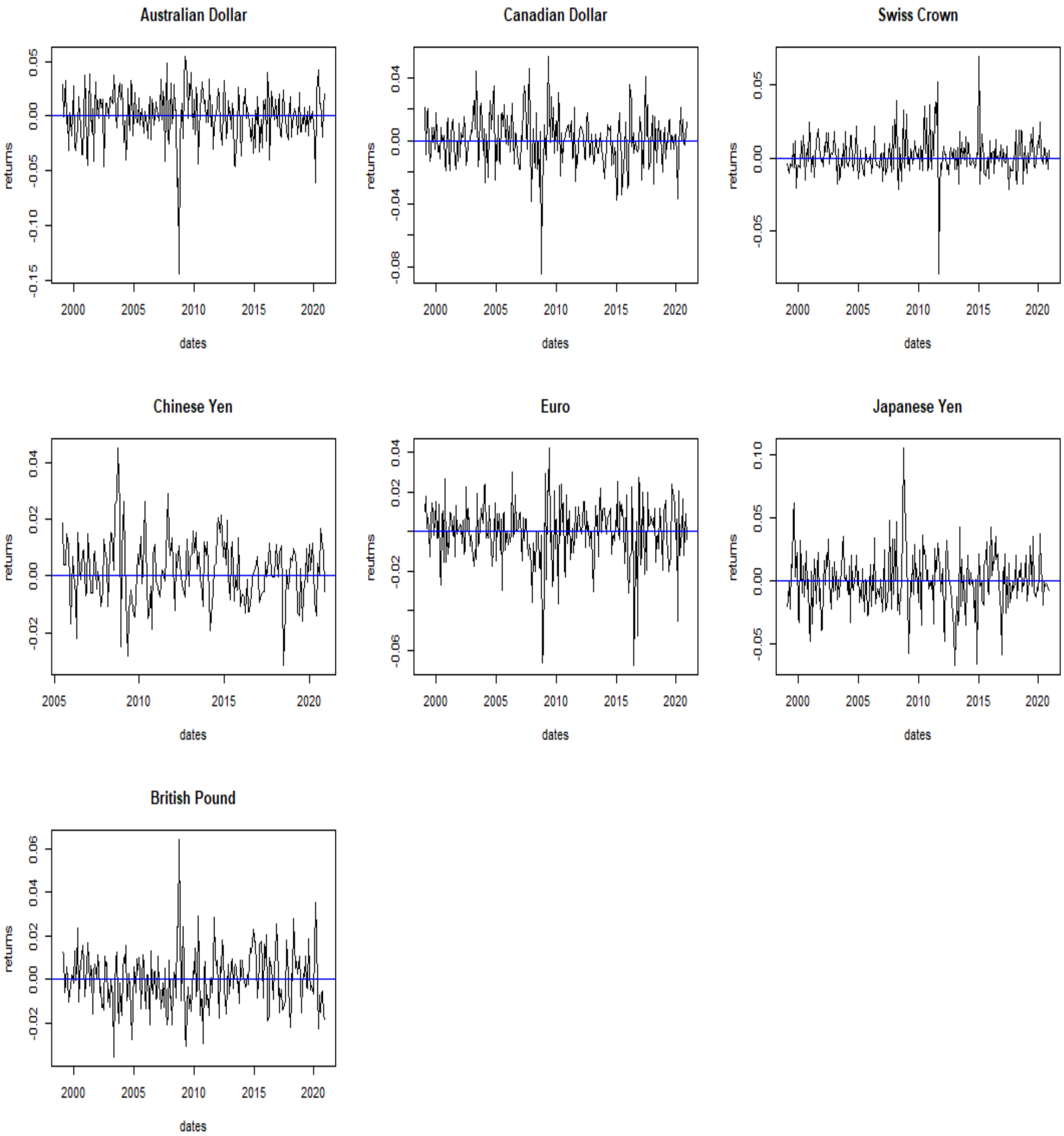
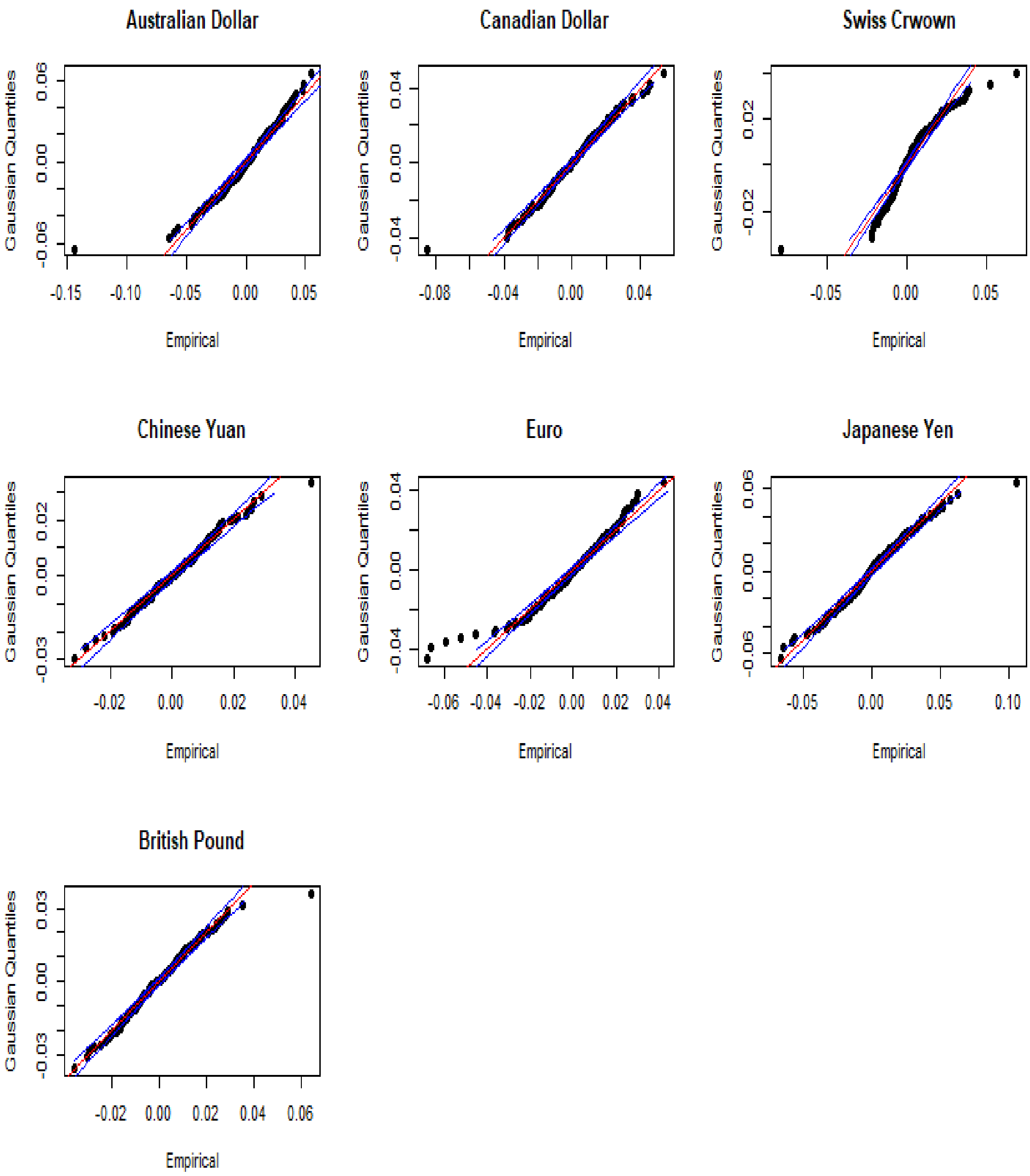
9. Annexes

Annex 1. Nominal Effective Exchange Rates returns (NEERRs).



Note. This annex refers to *Section* 3. The figure shows the nominal effective exchange rates returns of all currencies. The sample period starts in 1999:01 to 2020:12, except for China, which starts in 2005:01 due to the turnover of its monetary policy. The 'blue' line refers to the mean of zero of all the currency returns.

Annex 2. QQ-Plot of the nominal effective exchange rates.



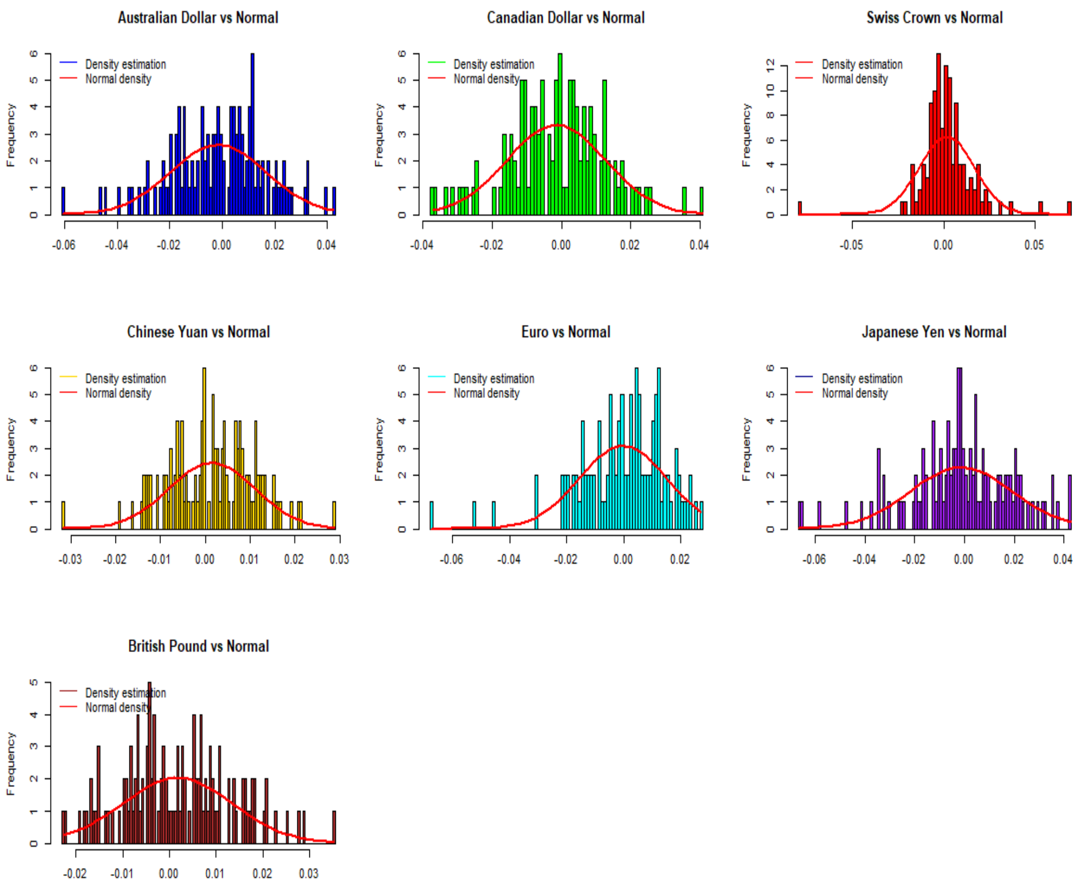
Note. We show in this figure the QQ-Plot which serve as a feature of the *Section* 3. It shows the comparison to a gaussian. The 'black' dotted line shows the performance of the nominal effective exchange rates returns versus the theoretical gaussian distribution.

Annex 3. Summary statistics of the subsampled NEERRs. Robustness Test 1.

Exchange Rates	Statistic			
	Skewness	Kurtosis	JB	*p*-value
AUS	-0,317	-2,705	2,662	0,264
CAD	-0,046	-2,635	0,926	0,629
CHF	-0,092	6,598	477,601	0,000
CNY	-0,182	-2,678	1,386	0,499
EUR	-1,207	0,016	77,858	0,000
JPY	-0,561	-2,157	10,488	0,005
UK	0,252	-3,315	1,654	0,437

Note. We use the NEERRs abbreviation introduced in *Section* 2. We present the summary statistics as a feature to compare the subsample (2011:01 – 2019:12) to the original sample period (1999:01 – 2020:12).

Annex 4. Histogram of the subsampled NEERRs. Robustness Test 1.



Note. This figure shows the histogram of the distribution of each subsampled currency. The 'red' line draws the probability distribution of a gaussian distribution.

Annex 5. Unit Root Test of the bilateral exchange rates. Robustness Test 2.

Exchange rates	ADF		PP		KPSS	
	$r_{i,t}$	$rr_{i,t}$	$r_{i,t}$	$rr_{i,t}$	$r_{i,t}$	$rr_{i,t}$
AUS	-1,90	-10,196	-1,72	-10,670	1,50	0,1166
CAD	-1,70	-10,049	-1,67	-11,831	1,29	0,219
CHF	-1,11	-7,886	-1,05	-8,995	3,45	0,173
CNY	-0,84	-8,979	-1,93	-12,787	31,99	0,076
EUR	-1,91	-10,245	-1,76	-11,837	1,08	0,079
JPY	-1,86	-8,888	-1,77	-12,426	0,79	0,084
UK	-1,57	-9,631	-1,56	-12,416	1,79	0,075

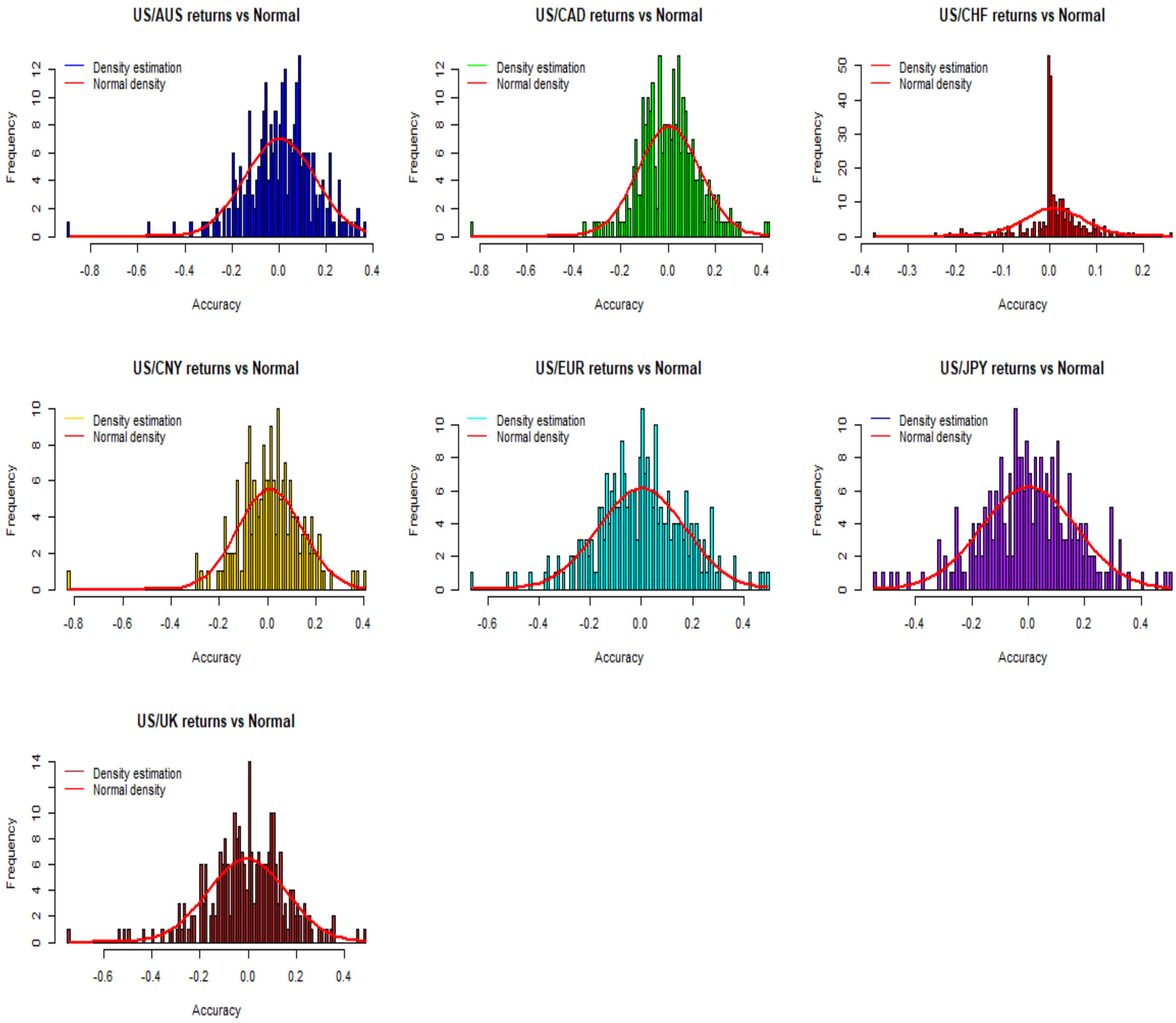
Note. This annex follows the same structure from Unit Root Test in *Section* 3. Now we contrast if the bilateral exchange rates ($r_{i,t}$) are stationary for the original period (1999:01 – 2020:12). $rr_{i,t}$ refers to the bilateral Exchange rates returns.

Annex 6. Summary statistics of the bilateral exchange rates returns. Robustness Test 2.

Exchange Rates	Statistic			
	Skewness	Kurtosis	JB	*p*-value
AUS	-1,024	1,752	300,194	0,000
CAD	-0,769	2,931	420,659	0,000
CHF	-1,089	3,532	530,627	0,000
CNY	-1,092	4,359	470,188	0,000
EUR	-0,198	-2,000	13,382	0,000
JPY	-0,125	-2,253	7,287	0,000
UK	-0,538	-0,984	59,090	0,00

Note. We use the NEERRs abbreviation introduced in *Section* 2. We present the summary statistics as a feature to compare the bilateral exchange rates returns to the baseline variable (NEERRs).

Annex 7. Histogram of the bilateral exchange rate returns. Robustness Test 2.



Note. This figure shows the histogram of the distribution of each bilateral exchange rate return. The 'red' line draws the probability distribution of a gaussian distribution.