Economic Policy Uncertainty Spillovers in Booms and Busts*

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Abstract

We estimate a nonlinear VAR to quantify the impact of economic policy uncertainty shocks originating in the U.S. on the Canadian business cycle in booms and busts. We find strong evidence in favor of asymmetric spillover effects. Uncertainty shocks originating in the U.S. explain about 12% of the variance of the 2-year ahead forecast error of the Canadian unemployment rate in periods of slack vs. just 2% during economic booms. Counterfactual simulations lead to the identification of a novel "economic policy uncertainty spillovers channel". According to this channel, spikes in U.S. economic policy uncertainty foster economic policy uncertainty in Canada in first place and, because of the latter, lead to a temporary increase in the Canadian unemployment rate. This channel is shown to work only in periods of slack. U.S. EPU shocks are shown to induce nonlinear unemployment responses in all G7 economies plus Brazil.

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1 Introduction

My view is that much of Canada's current economic policy uncertainty is due to contagion from the US. [...] Given the integrated and interdependent nature of the US and Canadian economies, this US-based economic policy uncertainty will continue to impede and adversely affect Canadian economic growth.

Nicholas Bloom, Fraser Alert, February 2013, p. 2.

Is economic policy uncertainty a driver of the business cycle? Baker, Bloom, and Davis (2016) address this question by constructing a novel index of economic policy uncertainty for the U.S. and a number of other countries. When employing such index in carefully designed VAR-based analysis, they find that increases in the level of uncertainty associated to policy decisions can explain a non-negligible share of the business cycle in the U.S. and other industrialized countries. This result is important for two reasons. First, because it reaffirms that uncertainty can very well be one of the drivers of fluctuations in real activity in the United States, a result previously found by a number of authors (for a recent survey, see Bloom (2014)). Second, because it points to a particular type of uncertainty - the one connected to policy decisions - as an independent source of fluctuations in real activity.

Most of the literature on uncertainty has focused on autarkic frameworks to identify the effects of an uncertainty shock. While being a natural first-step to understand the macroeconomic effects of movements in uncertainty, this assumption appears to be questionable for small-open economies, which are largely affected by shocks coming from neighboring countries and the rest of the world in general. As a matter of fact, however, little is known on the spillover effects related to second moment shocks, and - in particular - economic policy uncertainty shocks.

This paper contributes to the analysis of the transmission of second moment shocks in open economies by focusing on economic policy uncertainty spillovers from the United States to Canada. To this end, we estimate a monthly nonlinear Smooth Transition VAR (STVAR) model for the period 1985-2014 in which economic policy uncertainty shocks originating in the U.S. are allowed (but not necessarily required) to act as drivers of real activity in Canada.[1] We model a number of Canadian macroeconomic variables, including real activity indicators (industrial production, unemployment), inflation, the

[1] As discussed in Section 2, the sample choice is due to EPU data availability.

policy rate, and the US-Canada bilateral real exchange rate. In computing the effects of U.S. EPU shocks on the Canadian economy, we control for the Canadian EPU index, so that uncertainty shocks originating in the U.S. can affect the Canadian economy via uncertainty spillovers. Notice that a jump in policy-related U.S. uncertainty is potentially recessionary, and can in principle lead the Canadian economy to switch from - say - a boom to a bust. As a consequence, modeling absorbing states and estimating conditionally linear impulse responses would likely lead to biased results. Our analysis accounts for the possible transition from a state of the economy to another by computing Generalized Impulse Response Functions (GIRFs) à la Koop, Pesaran, and Potter (1996). This modeling choice implies that the probability of being in a given state of the business cycle is a fully endogenous object in our framework.

We find statistically and economically relevant nonlinear spillover effects. An economic policy uncertainty hike originating in the U.S. is estimated to trigger a strong and persistent downturn in Canada in the 1985-2014 period during bad economic times. An equally-sized shock, when occurring in booms, leads to quantitatively milder and mostly insignificant responses of real activity indicators. Monetary policy reacts by lowering the interest rate much more in bad than in good times. A forecast error variance decomposition exercise confirms that contagion via uncertainty shocks is a quantitatively more relevant phenomenon when Canada's growth rate is below trend. In particular, uncertainty shocks originating in the U.S. explain up to 12% of the variance of the 2-year ahead forecast error of the Canadian unemployment rate during slow-growth phases vs. about 2% during economic booms. One of the variables reacting in a significant and persistent fashion to U.S. EPU shocks is the Canadian EPU index. We then analyze the role played by the evolution of the latter in the transmission of the external EPU shocks to the Canadian economy. We do so by conducting a counterfactual simulation - focusing on economic busts - which shuts down the response of the Canadian EPU index to U.S. EPU shocks. The responses of the Canadian macroeconomic indicators turn out to be dramatically dampened, a result that points to the existence of a novel "economic policy uncertainty spillover channel". Our reading of the transmission mechanism is that hikes in the level of the U.S. economic policy uncertainty foster the build up of EPU in Canada and, consequently, exert a negative effect on the Canadian business cycle.

We focus on U.S. and Canada to investigate whether economy policy uncertainty originating in a large country can affect, and via which mechanism, business cycle fluctuations in a smaller open economy for two main reasons. First, the degree of interconnection between the U.S. and Canada is high. According to the Observatory of Economic Complexity (OEC), 74% of Canadian total export was imported by the United States, and 55% of Canadian imports came from the United States in 2014.[2] Second, first-moment shocks like technology, monetary policy, and fiscal shocks originating in the United States are typically found to be able to explain a sizeable fraction of the volatility of real activity in Canada (see, among others, Schmitt-Grohe (1998), Justiniano and Preston (2010), Kulish and Rees (2011), Faccini, Mumtaz, and Surico (2016)). For instance, Justiniano and Preston (2010) document that 52% of 2 year-ahead Canadian output growth volatility explained by first-moment U.S. shocks. Our paper complements these contributions by focusing on U.S. economic policy uncertainty shocks, which are second-moment shocks, and shows, using data for other six economies (Japan, UK, France, Germany, Italy and Brazil), that the asymmetric real effects of U.S. policy-related uncertainty shocks are not confined to the specific case of Canada.

Even though we model a number of macroeconomic variables, our analysis focuses mainly on the possibly asymmetric response of unemployment. Our search for asymmetric responses of unemployment is driven by a well-established theoretical and empirical literature. Chetty and Heckman (1986) show that exit costs lower than entry costs in a given industry may lead to fast drops in production and slow recoveries. Mortensen and Pissarides (1993) build up a model featuring job creation slower than job destruction due to search-related costs. This model delivers faster upward movement in unemployment than downward ones. Benigno and Ricci (2011) analytically show that downward wage rigidities imply a nonlinear aggregate supply curve which is vertical in presence of high inflation but flattens when inflation is low. Given the relationship between economic slack and low inflation, movements in aggregate demand caused by spikes in uncertainty may have larger real effects in periods of low growth. Cacciatore and Ravenna (2015) show that deviations from the efficient wage-setting due to matching frictions in the labor market combined with downward wage rigidities generate a strong and state-dependent amplification of uncertainty shocks and contribute to generate a countercyclical aggregate uncertainty. Sichel (1993) proposes a test for deepness and steepness and find empirical support for both when working with the U.S. unemployment rate. Evidence pointing to an asymmetric behavior of the U.S. unemployment rate is also provided by, among others, Koop and Potter (1999), van Dijk, Teräsvirta, and Franses (2002), Morley and Piger (2012), and Morley, Piger, and Tien (2013). Dibooglu and Enders (2001) find the Canadian unemployment rate to adjust nonlin-

[2] Data available at http://atlas.media.mit.edu/en/ .

early to its long-run equilibrium. Moreover, uncertainty dramatically increases during economic downturns, a countercyclical behavior which is also a characteristic of unemployment (Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2014), Jurado, Ludvigson, and Ng (2015)). Hence, the effects triggered by uncertainty shocks in recessions are likely to be different than those occurring in expansions. Recent evidence along this line is provided by, among others, Nodari (2014), Caggiano, Castelnuovo, and Groshenny (2014), and Caggiano, Castelnuovo, and Nodari (2015), and Caggiano, Castelnuovo, and Figueres (2016).

The structure of the paper is the following. Section 2 makes contacts with the extant literature. Section 3 details our empirical set up. In particular, it discusses the identification of an U.S. EPU-related uncertainty shock and presents the Smooth Transition VAR model we employ in our analysis. Section 4 presents the estimated dynamics responses of the Canadian economy to economic policy uncertainty spillovers coming from the United States. A list of robustness checks, which confirm the baseline results, are documented in Section 5. Section 6 looks at the importance of EPU shocks for the Canadian business cycle by reporting FEVD, and documents the existence of an "international economic policy uncertainty spillover" channel. Section 7 extends our analysis to the remaining G7 economies plus Brazil. Section 8 concludes.

2 Related literature

Our paper joins three different but related strands of the literature on the role of uncertainty shocks. First, a growing strand of the literature has studied the measurement and the macroeconomic effects of economic policy uncertainty. Baker, Bloom, and Davis (2016) develop country-specific indices of economic policy uncertainty. These indices are based on newspaper coverage frequency, and are shown by the authors to be closely related to movements in policy related economic uncertainty. In particular, the U.S. index is documented to peak near events like tight presidential elections, wars, 9/11, the failure of Lehman Brothers, and a number of battles over fiscal policy. The authors find that an upward movement in economic policy uncertainty leads to an increase in stock price volatility and a reduction in investment, output, and employment in the United States. A panel VAR modeling 12 major economies largely confirms this result. Our paper builds on Baker, Bloom, and Davis' (2016) and employs their EPU indices for the U.S. and Canada to study the spillover effects of hikes in EPU uncertainty from the former country to the latter. Other contributions using these EPU indices to study the macroeconomic impact of policy-related nucertainty shocks have mainly focused on the U.S. taken in isolation. Working with a VAR model, Benati (2013) shows that economic policy uncertainty to be able to explain a fraction of the 1-year ahead forecast error variance of the U.S. industrial production growth rate of about 20-30%, and to be an important driver of real activity also for the Euro area, the United Kingdom, and Canada. Mumtaz and Surico (2013) use a VAR to model a number of indicators of fiscal stance and find fiscal policy uncertainty to be a relevant driver of the American business cycle. Istrefi and Piloiu (2015) document a link between economic policy uncertainty and short- and long-run inflation expectations. Our contributions complement this literature by highlighting an international transmission channel which works asymmetrically along the business cycle in a small-open economy like Canada.

The second strand of the literature focuses on the role of uncertainty in an open economy context. Fernández-Villaverde, Guerrón-Quintana, Rubio-Ramírez, and Uribe (2011) and Born and Pfeifer (2014) find changes in the volatility of the real interest rate at which small open emerging economies borrow to exert effects on real activity in open economies such as Argentina, Ecuador, Venezuela, and Brazil. Benigno, Benigno, and Nisticò (2012) find shocks to the volatility of monetary policy shocks, inflation target shocks, and productivity shocks realizing in the U.S. to be important drivers of a number of nominal and real indicators in the G7. They propose a general-equilibrium theory of exchange rate determination based on the interaction between monetary policy and uncertainty, and show that their theoretical model is able to replicate the stylized facts identified with their VARs. Working with a VAR framework, Mumtaz and Theodoridis (2015) estimate that a one standard deviation increase in the volatility of the shock to U.S. real GDP leads to a decline in U.K. GDP of 1% relative to trend and a 0.7% increase in U.K. CPI at the two-year horizon. They propose a model featuring sticky prices and wages delivering predictions in line with their stylized facts. Colombo (2013) studies the spillover effects of an economic policy uncertainty shock originating in the United States for the Euro area. She finds such shocks to be an important driver of the European policy rate. Carrière-Swallow and Céspedes (2013) study the impact of uncertainty shocks originating in the U.S. on a number of developed and developing countries. They find substantial heterogeneity in the response of investment and consumption across countries. In particular, the response is more accentuated in developing countries, a stylized fact which the authors interpret in light of the different credit frictions affecting the functioning of financial markets in the countries under scrutiny. Gourio, Siemer, and Verdelhan (2013) build up a two-country RBC model in which aggregate uncertainty is time-varying and countries have heterogeneous exposures to a world aggregate shock. To test the empirical predictions of their framework, they construct a measure of international uncertainty by averaging up the volatility of equity returns of the G7 countries. They show that a shock to this measure of international uncertainty triggers a drop, rebound, and overshoot-type of response of industrial production in all these countries. Moreover, unemployment is also shown to respond to such shock. Cesa-Bianchi, Rebucci, and Pesaran (2014) employ a Global-VAR approach to study the effects of hikes in volatility on real activity for a number of industrialized and developing countries. They find the role of uncertainty shocks to be modest. Klößner and Sekkel (2014) study international spillovers of policy uncertainty and find evidence in favor of economic policy uncertainty connectedness for a number of countries, with the U.S. being the main exporter of policy uncertainty. Handley (2014) and Handley and Limão (2014, 2015) study the interconnections between policy uncertainty, trade, and real activity in a number of countries. They find policy uncertainty to be a key factor affecting trade and investment decisions. Similar conclusions are reached by Born, Müller, and Pfeifer (2013), who find that terms of trade uncertainty may be a relevant driver of real GDP in Chile. Our paper adds to this literature by unveiling the effects that economic policy uncertainty shocks originating in the U.S. exert as regards the Canadian business cycle. This result, which points to the relevance of external second moment shocks for a small open economy like Canada, complements previous contributions focusing on spillover effects from the U.S. to Canada due to first-moment shocks (see, for instance, Schmitt-Grohe (1998), Justiniano and Preston (2010), and Faccini, Mumtaz, and Surico (2016)).

The third strand of the literature regards the effects of uncertainty shocks on real activity as predicted by micro-founded DSGE models. Gilchrist and Williams (2005) work with a standard real business cycle model featuring a Walrasian labor market. They show that uncertainty shocks are expansionary because, in their model, they exert a negative effect on households' wealth, increase the marginal utility of consumption and, therefore, labor supply, which eventually increases output. A different perspective is offered by Leduc and Liu (2016). They show that a labor market model featuring matching frictions predict a negative impact on output by uncertainty shocks. This negative effect is related to an optimal "wait-and-see" strategy implemented by firms because of the lower expected value of filled vacancies in presence of uncertainty. This leads firms to post a lower number of vacancies, which leads to a lower number of matches on the labor market in equilibrium. Sticky prices are shown to magnify this effect due to the negative impact of uncertainty on aggregate demand and, consequently, on firms' relative prices, whose fall imply an even lower number of vacancies posted in equilibrium. Basu and Bundick (2014) also work with a model featuring sticky prices and show that their framework is able to replicate the conditional (on an uncertainty shock) comovements often found in the data. Back to RBC models, Bloom (2009) show that a partial equilibrium framework modeling firms' decisions over labor and investment in presence of non-convex adjustment costs imply an optimal "wait-and-see" strategy which implies a drop in real activity after an uncertainty shock. When estimating his model with micro-data, he finds such costs to be empirically relevant, above all those related to changes in investment. Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2014) augment Bloom's (2009) framework by modeling households' consumption-savings decisions. They show that the negative real activity effects to an uncertainty shock are still present when allowing households to pursue consumption smoothing. Our results support models predicting a drop in real activity after an uncertainty shock, and stress that this is particularly true when the economy features unused capacity.

3 Modeling asymmetric spillover effects: Shocks and dynamics

U.S. EPU index. As anticipated in the Introduction, we use as proxies of economic policy-related uncertainty the indices developed by Baker, Bloom, and Davis (2016) for the U.S. and a number of other industrialized countries. This index is based on newspaper coverage frequency. As regards the United States, Baker, Bloom, and Davis use two overlapping sets of newspapers. The first spans the 1900-1985 period and comprises the Wall Street Journal, the New York Times, the Washington Post, the Chicago Tribune, the Los Angeles Times, and the Boston Globe. From 1985 until 2012, USA Today, the Miami Herald, the Dallas Morning Tribune, and the San Francisco Chronicle are added to the set. The authors perform month-by-month searches of each paper, starting in January of 1900, for terms related to economic and policy uncertainty. In particular, they search for articles containing the term "uncertainty" or "uncertain", the terms "economic", "economy", "business", "commerce", "industry", and "industrial", and the terms: "congress", "legislation", "white house", "regulation", "federal reserve", "deficit", "tariff", or "war". The article is included in the count if it includes terms in all three categories pertaining to uncertainty, the economy and policy.

To deal with changing volumes of news articles for a given paper over time, Baker, Bloom, and Davis (2016) divide the raw counts of policy uncertainty articles by the total number of news articles containing terms regarding the economy or business in the paper. They then normalize each paper's series to unit standard deviation prior to December 2009 and sum each paper's series. Details are reported in Baker, Bloom, and Davis (2016).

We now turn to the description of the nonlinear model we employ in our empirical analysis.

STVAR model. We allow for asymmetric spillover effects by modeling Canadian macroeconomic indicators with a Smooth-Transition VAR framework (for a reference textbook, see Teräsvirta, Tjøstheim, and Granger (2010)). Formally, our STVAR model reads as follows:

$$\boldsymbol{X}_t = [1 - F(z_{t-1})]\boldsymbol{\Pi}_R(L)\boldsymbol{X}_t + F(z_{t-1})\boldsymbol{\Pi}_E(L)\boldsymbol{X}_t + \boldsymbol{\varepsilon}_t \quad (1)$$

$$\boldsymbol{\varepsilon}_t \sim N(0, \boldsymbol{\Omega}) \quad (2)$$

$$F(z_t) = \{1 + \exp[-\gamma(z_t - c)]\}^{-1}, \gamma > 0, z_t \sim d(0,1) \quad (3)$$

where $\boldsymbol{X}_t$ is a set of endogenous variables we aim to model, $\boldsymbol{\Pi}_R$ and $\boldsymbol{\Pi}_E$ are the VAR coefficients capturing the dynamics of the system during phases of slack and booms (respectively), $\boldsymbol{\varepsilon}_t$ is the vector of reduced-form residuals having zero-mean and variance-covariance matrix $\boldsymbol{\Omega}$, $F(z_{t-1})$ is a logistic transition function which captures the probability of being in a boom and whose smoothness parameter is γ, z_t is a transition indicator, and c is the threshold parameter identifying the two regimes. In brief, this model combines two linear VARs, one capturing the dynamics of the economy during busts and the other one during booms. The transition from a regime to another is regulated by the smoothness parameter γ. Large values of γ imply abrupt switches from a regime to another, while moderate ones point to regimes of longer duration.[3]

A key choice for our empirical exercise is that of the transition indicator z_t. A standard choice in the literature is to consider a moving average of the growth rate of real GDP, which offers a good approximation of the ups and downs experienced by the U.S. business cycle (see, among others, Auerbach and Gorodnichenko (2012),

[3] Mumtaz and Theodoridis (2016) point to a different way of modelling the possibly evolving role played by uncertainty shocks with an application for the U.S. in which impulse responses are allowed to be time-dependent. A comparison between state- and time-dependent effects of economic policy uncertainty spillovers is material for future research.

Bachmann and Sims (2012), Caggiano, Castelnuovo, and Groshenny (2014), Berger and Vavra (2014), Nodari (2014), Caggiano, Castelnuovo, Colombo, and Nodari (2015), and Figueres (2015)). Notice that an alternative to modeling a smooth transition from a regime to another with an observable indicator would be to model the switch by estimating a latent factor process as in the context of a different - although related - regime switching model (for an extensive presentation, see Hamilton (2016b)). We prefer using an observable to determine the regimes in our model (conditional on the estimated values of the logistic function $F(z_t)$) to ease the comparison of our estimated impulse responses to the theoretical and empirical literature cited in the Introduction and in Section 2, which motivates the asymmetric dynamics of the unemployment rate over the business cycle.

Our empirical exercise deals with monthly data to maximize the number of observations for the countries we study while retaining the possibility of studying the impact of EPU uncertainty shocks via the indexes developed by Baker, Bloom, and Davis (2016) for the U.S. and Canada. We use two lags, as indicated by the AIC. As transition indicator, we employ a moving average of the growth rate of industrial production.[4] Conditional on our choice for z_t, we jointly estimate the parameters $\{\mathbf{\Pi}_R, \mathbf{\Pi}_E, \mathbf{\Omega}, \gamma, c\}$ of model (1)-(3) via conditional maximum likelihood as suggested by Teräsvirta, Tjøstheim, and Granger (2010).[5]

Modeled vector. We model the Canadian economy with the following vector of U.S. and Canadian observables: $\boldsymbol{X}_t = [EPU_t^{US}, EPU_t, \overline{\Delta IP}_t, u_t, \pi_t, R_t, \Delta\epsilon_t]'$. The variable EPU_t^{US} is the U.S. EPU uncertainty index constructed by Baker, Bloom, and Davis (2016). All the remaining variables in the vector $\boldsymbol{X}_t$ refer to the Canadian economy. In particular, EPU_t stands for the Canadian uncertainty index, $\overline{\Delta IP}_t$ stands for the eighteen-term moving average of the monthly growth rate of industrial production (percentualized and annualized), u_t is the unemployment rate, π_t stands for CPI inflation (y-o-y percentualized growth rate of the monthly index), R_t is the federal funds rate,

[4] We employ a moving average of the month-by-month growth rate of industrial productionf featuring eighteen terms. The number of moving average terms is determined by maximizing the correlation between our transition variable and the dating of Canadian recessions as defined by the Economic Cycle Research Institute (https://www.ecri.org). Our Appendix shows that our results are robust to two alternative transition indicators, a moving average of the real GDP growth rate and the common factor computed via a principal component analysis which considers the growth rates of industrial production and real GDP and the rates of unemployment and employment.

[5] Teräsvirta, Tjøstheim, and Granger (2010) point out that γ is not a scale-free parameter. To make it scale free, we follow their suggestion (p. 381 of their book) and standardize the transition indicator so that z_t is a zero-mean, unitary standard deviation variable. This choice makes our estimates more easily comparable with those present in the extant literature.

while $\Delta\epsilon_t \equiv \pi_t^{US} + \Delta s_t^{CANUS} - \pi_t^{CAN}$ is the growth rate of the bilateral real exchange rate between Canada and the U.S. constructed by considering the inflation rates in the two countries and combining it with Δs_t^{CANUS}, which is the y-o-y growth rate of the Canada/US nominal exchange rate.[6]

We consider the sample 1985M1-2014M10. The beginning of the sample is dictated by the availability of the Canadian EPU index produced by Baker, Bloom, and Davis (2016), which we use here to make sure that spikes in the U.S. EPU index deliver information over and above the one delivered by abrupt changes in the Canadian one.[7] The end of the sample is justified by the end of the availability of the EPU historical index for the United States.[8] The EPU indices were downloaded from the http://www.policyuncertainty.com/ website. All remaining data were downloaded from the Federal Reserve Bank of St. Louis' website.

Linearity test. We test if a nonlinear framework provides us with a statistically better representation of the covariance structure of the data $\boldsymbol{X}_t$ than a standard linear multivariate framework. Teräsvirta and Yang (2014) propose a Lagrange Multiplier test of the null hypothesis of linearity vs. a specified non-linear alternative that is exactly the logistic STVAR framework with a single transition variable. The Lagrange Multiplier statistic is 94.545, and the computed p-value equal to 0.01 clearly points to the rejection of the null hypothesis of linearity of the model. Details on this test are reported in our Appendix.

[6]The Canadian EPU index is constructed by Baker, Bloom, and Davis (2016) by searching keyword terms such as "spending", "policy", "deficit", "budget", "tax", "regulation", and "central bank" in six different newspapers, which are "the Gazette", "Globe and Mail", "Canadian Newswire", "Ottawa Citizen", "Toronto Star", and "Vancouver Sun".

[7]In February 1991, the Bank of Canada officially adopted an inflation target. Our results are robust to the employment of the sample 1991M2-2014M10.

[8]To be precise, there are two U.S. EPU indices available at http://www.policyuncertainty.com/ . One is the historical version of the EPU index, which is the one we use in our analysis. The other one is an index available since 1985 and constantly updated by the researchers behind the EPU project. This latter index measures policy-related economic uncertainty on the basis of three components, i.e., uncertainty as present in selected newspapers, federal tax code provisions set to expire in future years, and disagreement among economic forecasters as a proxy for uncertainty. Differently, the historical EPU index is constructed on the newspaper-component only. To preserve homogeneity and, at the same time, maximize the degrees of freedom of our exercise, we focus on the historical version of the EPU index.

4 EPU spillovers: Empirical evidence

This Section reports our main empirical findings. We begin by describing the identified U.S. EPU shocks. We then show the estimated probability of slack for Canada according to our model. Finally, we report the GIRFs of the Canadian macroeconomic indicators to an uncertainty shock coming from the United States.[9]

EPU shocks. We identify U.S. EPU shocks by orthogonalizing the residuals $\boldsymbol{\varepsilon}_t$ in eq. (1) via a Cholesky-decomposition of the variance-covariance matrix $\boldsymbol{\Omega}$. Since we place the U.S. EPU index first in the vector $\boldsymbol{X}_t$, this identification scheme implies that Canadian variables cannot exert a contemporaneous impact on the U.S. uncertainty index. This assumption is weaker than the block-exogeneity assumption usually entertained when working with a small-open economy model for Canada, and let the data free to speak as regards possible feedbacks from Canada to the United States.

Figure 1 plots the estimated series of the U.S. EPU shocks. Vertical lines identify upward spikes in this series, which can be interpreted as "large" uncertainty shocks.[10] We give all these spikes an interpretation based on historical facts, which we report in Table 1. Some spikes regard fiscal or monetary-policy related events like discussions on the budget and the fiscal cliff. These are shocks which we associate to domestic (U.S.) economic conditions, which are likely to be exogenous to the Canadian economy. All these events can potentially increase the uncertainty on how economic policy will operate in the future in the U.S. and, as such, represent important drivers behind firms' and households' economic decisions, that eventually affect real activity, both domestically and in countries which are strictly interconnected to the United States, Canada in first place. A few spikes relate to events like the Gulf War I in 1991, the invasion of Iraq in 2003, and the acceleration of the Global Financial Crises in 2008, which can be classified as "global" (i.e., non-U.S. only) events. Our Section on robustness checks document that our results are robust to shocks identified with a U.S. EPU dummy which consider only U.S. related events.

Probability of being in a slack period. Figure 2 plots the probability of being in a negative phase of the business cycle for Canada and contrasts it with the 1990-92 and 2008-09 recessions as dated by the Economic Cycle Research Institute (ECRI).[11]

[9] In a related paper (Caggiano, Castelnuovo, and Figueres (2016)), we report estimates for the U.S. case that point to asymmetric effects of EPU shocks for the U.S. unemployment rate.

[10] These large shocks are identified as positive realizations of the U.S. EPU shocks estimated with our baseline model (and displayed in Figure 1) which exceed the value of two standard deviations of the shock.

[11] We are aware of two official datings of the business cycle for Canada. The first one is

Our estimated logistic function for Canada detects both recessions. The delay via which these two deep downturns are tracked is due to the backward-looking nature of the transition indicator we use. Conditional on our estimated threshold $\widehat{c}$, our model classifies about 20% of the observations in the sample as recessions, a larger fraction than the 12% the ECRI classification suggests. This is mainly due to the fact that our logistic function also points to a deep downturn in the early 2000s, which is not classified as a recession by the ECRI. As explained in detail in our Appendix, the reason for this discrepancy is the following. The early 2000s saw Canada experience a drop in production as large as the one experienced during the two ECRI recessions in our sample. However, labor market indicators pointed to a strong downturn, but not to a clear recession.[12] Hence, while the early 1990s and the 2008-09 periods clearly featured strong and converging signals in favor of a recession, the early 2000s looked more like a severe downturn. In light of this evidence, our analysis should be interpreted as focusing on phases of growth of industrial production above vs. below the sample average, more than on official "expansions" and "recessions".

GIRFs. Figure 3 plots the nonlinear impulse responses of a selected subset of Canadian macroeconomic variables to a one-standard deviation shock to the U.S. EPU shock, along with 68% confidence bands computed with the bootstrap-after-bootstrap strategy proposed by Kilian (1998).[13] We focus in particular on unemployment and the growth rate of industrial production as real activity indicators, and inflation and the policy rate because of their policy-relevance. Several comments are worth making. First, the response of unemployment and industrial production is clearly asymmetric. In particular, the response of real activity is strong and statistically relevant during busts, while it is economically modest and statistically insignificant in booms. Second,

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the one provided by the ECRI, and it is available at https://www.businesscycle.com/ecri-business-cycles/international-business-cycle-dates-chronologies . The second one is provided by the C.D. Howe Institute, and it is available here: https://www.cdhowe.org/council/business-cycle-council . While following slightly different procedures for the dating of the business cycle, these Institutes point to very similar datings of the Canadian business cycle. Our choice of the ECRI dating is due to internal consistency, in that such dating for the U.S. basically corresponds to the one provided by the NBER.

[12] The Canadian unemployment rate went up from 6.8% to 8.1% from January 2000 to the end of 2001. The variation (difference between these two rates) reads 1.3%. Differently, the unemployment rate jumped from 7.8% to 10.5% in the 1988-1991 period (difference: 2.7%) and from 6.1% to 8.6% during the Global Financial Crisis (difference: 2.5%).

[13] Our GIRFs are computed by considering all realizations (and the corresponding initial conditions) of our transition indicator below/above the estimated threshold as busts/booms. Our Appendix shows that our results are robust to selecting initial conditions corresponding to more "extreme" realizations of the business cycle which, without doubt, can be classified as belonging to the "busts"/"booms" regimes. For an example in the literature of this "extreme events" analysis, see Caggiano, Castelnuovo, Colombo, and Nodari (2015).

there is significant evidence of a spillover effect going from the U.S. to Canada during phases of slack. An unexpected hike in the American economic policy uncertainty index triggers an increase in the Canadian unemployment rate, a decrease in industrial production, and a significant response of inflation and the policy rate. Third, differently from unemployment, industrial production displays an abrupt drop, and quick rebound, and a prolonged (but temporary) overshoot when the shock hits in a phase of slack. This pattern is in line with the one predicted, for real activity indicators, by Bloom's (2009) partial equilibrium model featuring labor and investment non-convex adjustment costs. Differently, the reaction of industrial production is insignificant when the shock hits in expansions. Fourth, the response of inflation is found to be different in the two states not only quantitatively but also qualitatively. The response of the growth rate of domestic CPI is negative, and persistently so, in periods of slack, a behavior consistent with a demand-driven interpretation of price formation. Viceversa, a positive short run reaction is detected when uncertainty hits during booms. This result may find its rationale in the behavior of firms operating in an environment facing price and wage stickiness. As pointed out by Mumtaz and Theodoridis (2015), firms in this environment may optimally decide to increase their prices to avoid getting stuck with "too costly" contracts, i.e., sub-optimally high real wages. Most likely, the different response of the inflation rate in the two states is the reason why the policy rate suggests a prolonged easing in recessions and a short-lived tightening in expansions. As documented by Figure 4, these responses are statistically different between states.[14]

5 Robustness checks

We check the robustness of our baseline results along four different dimensions: i) the identification of U.S.-related EPU shocks; ii) the inclusion of proxies of U.S. financial and economic uncertainty; iii) the control for U.S. first shocks; iv) the control for commodity and oil price fluctuations.

Dummy. The results shown before rely on the use of the EPU index for the U.S. as an observable in the VAR whose orthogonalized residuals are interpreted as U.S. shocks external to Canada. However, some of the spikes of the EPU index can be attributed to events connected to global pressure. Davis (2016) proposes a Global Economic Policy

[14] To account for correlation between the impulse responses in the two states, the differences plotted in Figure 4 are computed conditional on the same set of bootstrapped residuals. The empirical density of the difference is estimated using 500 realizations per each horizon of interest.

Uncertainty (GEPU) constructed by considering a GDP-weighted average of national EPU indices for 16 countries that account for two-thirds of global output. The national EPU indices are constructed following Baker et al.'s (2016) newspaper-based approach. In our sample, the GEPU index rises sharply in correspondence of the Asian Financial Crisis, the 9/11 terrorist attacks, the U.S.-led invasion of Iraq in 2003, the Global Financial Crisis in 2008-09, and the European immigration crisis.[15] Some global events are indeed picked up by the estimated U.S. EPU shock plotted in Figure 1. In particular, the Gulf War I spike, the one corresponding to the Iraq invasion, and the one identifying the peak of uncertainty due to the Global Financial Crisis can safely be considered as global shocks, more than domestic (U.S.) shocks.

How relevant are these global shocks for our result? We address this question by constructing a U.S. EPU dummy which takes value 1 only for those events that can be safely classified as U.S.-specific. Table 1 provides details on the U.S.-specific EPU shocks we consider. This dummy is then included in our STVAR in lieu of the EPU index to check the solidity of our baseline results to a different identification scheme that comes from an event-based approach, where shocks that are possibly global are excluded.

Uncertainty last. Our baseline model assumes that both the U.S. and the Canadian EPU indicators are not contemporaneously influenced by any of the shocks originating in Canada. This assumption appears to be plausible and fully consistent with the block-exogeneity approach typically employed when it comes to modeling the interaction between a big economy like the United States and a small-open economy like Canada (see, e.g., Justiniano and Preston (2010)). However, while this assumption is typically entertained for aggregates like inflation and output, less is known on the interconnections between economic policy uncertainty in neighboring countries strictly related by intense trading flows. To understand how relevant this assumption is for our results, we then run a check in which we order U.S. and Canada EPU last, i.e. after the block of Canadian macro variables to allow uncertainty to react on impact to Canadian first moment shocks.

VXO. The EPU index constructed by Baker, Bloom, and Davis (2016) captures economic policy-related spikes in uncertainty. Obviously, one concern related to our analysis is to what extent we are capturing effects coming from spikes in economic

[15]Perhaps not surprisingly, the correlation between the GEPU index and the U.S. EPU one is very high and equal to 0.84.We avoid jointly modeling them in our vector to avoid issues related to multicollinearity.

policy uncertainty as opposed to different aspects of economic uncertainty. We tackle this issue by considering two alternative indicators of uncertainty. The first one is the VXO, which is the S&P 100 implied volatility index computed by the Chicago Board Options Exchange. The VXO index captures the evolution of the volatility of expected stock market returns, and it has been used since Bloom's (2009) contribution as a measure of broad economic uncertainty in applied macroeconomic investigations.[16] This exercise is conducted to control for a financial measure of uncertainty which also spikes up in correspondence of events like, e.g., 9/11 which drove the U.S. EPU index up. As stressed by Stock and Watson (2012), uncertainty shocks and liquidity/financial risk shocks are highly correlated, which makes their separate interpretation problematic.[17] The idea of our robustness check is to obtain a purged measure of the U.S. EPU shocks which is not driven by financial uncertainty.[18] Following Baker, Bloom, and Davis (2016), we order the VXO after the U.S. EPU index and before the Canadian block of variables in our vector.

Economic Uncertainty. Another possibility is that of confounding economic policy uncertainty with the broader concept of economic uncertainty. Baker, Bloom, and Davis (2016) construct an overall Economic Uncertainty (EU) index by dropping all terms related to policy in the keyword-based search they conduct. A full documentation on the construction of this index is provided in Baker, Bloom, and Davis (2016), who also compare the characteristics of the EPU and EU indices. The overall EU index is probably the most natural indicator we can use to make the policy component of the U.S. EPU shocks emerge in our empirical exercise.[19] As before, we follow Baker,

[16] A close measure is the S&P 500 Volatility index computed by the Chicago Board Options Exchange, which is known as the VIX. The correlation between the VIX and the VXO at a monthly frequency in the sample January 1990 (first month of availability of the VIX)-October 2014 is 0.99. We prefer to work with the VXO because it goes back in time to January 1986.

[17] For contributions aiming at separating uncertainty and financial shocks, see Christiano, Motto, and Rostagno (2014), Furlanetto, Ravazzolo, and Sarferaz (2014), and Caldara, Fuentes-Albero, Gilchrist, and Zakrajšek (2016).

[18] Notice that alternative measures of uncertainty are currently available, e.g., the one recently proposed by Ludvigson, Ma, and Ng (2016). Such measure is constructed following the data-rich approach modeling the expected volatility of a large number of financial series proposed by Jurado, Ludvigson, and Ng (2015), who model a broader macroeconomic uncertainty measure combining financial and real economic indicators. Ludvigson, Ma, and Ng (2016) find that financial uncertainty is likely to be a relevant driver of the U.S. business cycle. Notably, their estimate of the financial market uncertainty index conditional on a one-month horizon is highly correlated (0.84) with the VXO in our sample. We see this empirical fact as a validation of our choice to use the VXO as a proxy of a broader measure of uncertainty.

[19] The EU index is available here: http://www.policyuncertainty.com/Replication_Files.zip . This series is quarterly. We then construct a monthly counterpart via quadratic-match average, which performs a proprietary local quadratic interpolation of the low frequency data to fill in the high

Bloom, and Davis (2016) and order the EU index just after the U.S. EPU index.

Excess bond premium. Gilchrist and Zakrajšek (2012) propose a micro-founded measure of excess bond premium (EBP). Such measure of credit spread is constructed by controlling for the systematic movements in default risk on individual firms. Consequently, the EBP isolates the cyclical changes in the relationship between measured default risk and credit spreads. Gilchrist and Zakrajšek (2012) show that the EBP has predictive power for a number of U.S. real activity indicators. Moreover, when embedded in a VAR to quantify the effects of a credit shock, unexpected jumps in EBP are found to be associated to temporary but economically significant recessions and deflations. It may very well be that movements in EBP caused some of the movements in the U.S. EPU index, an example being the high realization of EPU in correspondence of the Black Monday. We consider this possibility by adding EBP on top of our baseline vector to control for credit shocks.

Factor-Augmented STVAR. Our baseline model indicates that a substantial chunk of the volatility of the Canadian unemployment rate could be due to a second moment shock coming from the United States. However, a number of U.S. first moment shocks - among others, technology, fiscal, and monetary policy shocks - are likely to be at play and influence the Canadian economy. While the separate identification of each of these shocks is left to future research, it is clearly important to control for a composite of these first moment disturbances to minimize the probability of an upward bias as regards the contribution of U.S. EPU shocks on the Canadian unemployment. To tackle this issue, we proceed as follows. First, we compute common factors explaining the bulk of the volatility of a large set of U.S. series via a principal component approach. We then consider the FRED-MD dataset recently organized by McCracken and Ng (2016). This macroeconomic database, which comprises 134 monthly U.S. indicators, enables us to compute U.S. common factors by relying on a data-rich approach.[20] Second, we consider the first factor in terms of contribution to the variance of the series belonging to the FRED-MD and add it as first variable to our baseline vector. This two-step procedure is meant to emulate the Factor-Augmented VAR (FAVAR) approach proposed by Bernanke, Boivin, and Eliasz (2005) for the identification of a monetary policy shock. Given that our study employes a nonlinear STVAR framework, we term the model enriched with a factor as Factor-Augmented STVAR (FASTVAR).

observations.

[20] The database can be downloaded from the website http://research.stlouisfed.org/econ/mccracken/sel/ .

Commodity/oil prices. Canada is a resource-rich country which exports oil and other commodities. As documented by Charnavoki and Dolado (2014), energy products represented 23.5% of total merchandise exports in 2010, while other basic products and materials related to to the agriculture sector, forestry and mining accounted for about 40% of those exports. Charnavoki and Dolado (2014) investigate the relevance of shocks to commodity prices for the Canadian economy via a structural dynamic factor model. They measure commodity prices by computing the common factor of a range of indices for energy, food, agricultural raw materials, base metals, and fertilizers, and find commodity price shocks to be an important driver of the Canadian business cycle. Among commodity prices, oil price represents a particularly relevant factor for business cycle fluctuations in a small open economy like Canada both for its direct impact on Canadian exports and for its potential indirect impact via its effects on the U.S. economy. In a series of paper, Hamilton (see, e.g., Hamilton (2003), Hamilton (2011), Hamilton (2016a)) shows that oil price fluctuations have preceded all U.S. recessions included in our sample. Hence, oil prices may very well be an important driver of both uncertainty and real activity in the U.S. and Canada. Our baseline framework does not feature commodity and/or oil prices. Hence, we run three robustness checks in which we enrich our baseline vector with, alternatively, Charnavoki and Dolado's global commodity price factor, and with two measures of oil prices: the producer price index for crude petroleum and refiner acquisition cost for imported oil.[21]

Figure 5 displays the outcome of our robustness checks. A few comments are in order. First, our baseline result is clearly robust to the employment of our U.S. EPU dummy. The difference between the responses of unemployment obtained by excluding possibly global shocks points clearly to a stronger effect in busts. More generally, the main baseline finding is robust across all robustness checks. Second, shocks other than the U.S. EPU one evidently affect the Canadian unemployment rate. The baseline response of unemployment is dampened in most scenarios, with a reduction of the peak

[21]As regards Charnavoki and Dolado's measure, we compute the common factor of the commodity price indexes as documented in their paper. The source of those measures is the website of the *American Economic Journal: Macroeconomics* outlet (see the link pointing to Charnavoki and Dolado's paper). The producer price index has been downloaded from the St. Louis Fed FRED website, while the refiner acquisition cost has been downloaded from the Energy Administration Information website.The reason for using both measures, alternatively, in our robustness checks is due to the possibly different effects of oil shocks obtained by using these different price measures, as highlighted by Hamilton (2003, 2011) and Kilian and Vigfusson (2011) respectively. For this reason, in Figure 5 we label the producer price inedx as "oil Hamilton" and the refiner acquisition cost as "oil Kilian". Both series have been deflated using the CPI. Results are robust to using nominal instead of real prices (evidence available upon request).

response of about 40% in a variety of models. In particular, the models accounting for first moment U.S. shocks, broad economic uncertainty, and fluctuations in oil and commodity prices are those that return the lowest peak reactions of unemployment to an EPU shock. Third, out of the just mentioned models, those incorporating information on EU, oil, and commodity prices predict the peak of unemployment to come after a few months and imply the lowest integral of the response of unemployment. Differently, the model featuring first moment shocks predict unemployment to peak after one year and a somewhat slower speed of convergence towards the steady state. Fourth, the across-model heterogeneity of unemployment responses observed in busts is larger that observed in booms. This fact suggests that model misspecification due to the omission of relevance macroeconomic shocks is likely to be more relevant when studying U.S. EPU spillovers in the context of Canadian busts, more than when scrutinizing Canadian booms.

6 EPU shocks: Contribution and transmission mechanism

The results documented so far speak in favor of the fact that variations in the U.S. EPU index can be associated to fluctuations in real activity, inflation, a short-term interest rate, and the real exchange rate in Canada. But how strong is this relationship? And what is the transmission mechanism, really? We answer these questions by considering, in turn, the results coming from a forecast error variance decomposition (FEVD) analysis and from a counterfactual exercise aiming at isolating the role of the Canadian EPU for the transmission of U.S. EPU shocks to the Canadian economy.

FEVD. We conduct the forecast error variance decomposition analysis by implementing the algorithm by Lanne and Nyberg (2016), who propose a generalized version of the forecast error variance decomposition for multivariate nonlinear models. Table 2 collects the figures related to the forecast error variance decomposition analysis conditional to a 24-month horizon.[22] We begin by looking at the FEVD conditonal to economic busts obtained with our baseline specification. A number of considerations are in order. First, as shown by the first row of the Table, in bad times jumps in the U.S. EPU shocks explain 24% of the volatility of the Canadian unemployment rate. Hence, EPU spillovers are quantitatively important to explain the dynamics of a key

[22] A FEVD analysis focusing on a 12-month horizon delivers very similar results, which are available upon request.

labor market variable such as the unemployment rate. Interestingly, movements in the Canadian EPU index explain about 23% of the Canadian unemployment rate. These numbers points to EPU shocks coming from the U.S. as being as important as domestic Canadian EPU shocks, a result consistent with Klößner and Sekkel's (2014) evidence pointing to policy spillovers from the United States to Canada. Moreover, uncertainty is important in general, given that it is responsible for about 47% of the variation in unemployment at a 2-year horizon. Second, looking at the FEVD in booms shows that the role of uncertainty is relevant in bad times only. Indeed, these figures dramatically drop to 4% (U.S. EPU shocks) and 6% (Canadian EPU shocks) when it comes to explaining unemployment during expansionary phases of the Canadian business cycle. A similar result holds true as regards industrial production, with uncertainty shocks explaining about 8% (U.S. EPU) and 14% (Canadian EPU) in busts, and about 3% and 5% in booms. The contribution of external economic policy uncertainty shocks to the volatility of inflation, the short-term interest rate, and the bilateral real exchange rate reads, respectively, 14%, 18%, and 15% in busts while it ranges from 4% to 7% in booms. Again, independently of the state of the economy, these figures are found to be fairly in line with the contribution of the Canadian EPU shocks.

Another interesting result of our FEVD analysis regards the drivers of the EPU indices employed in our analysis. As reported in Table 2, about 63% of the volatility of the U.S. EPU index in busts is driven by its own innovation, while the contribution of the Canadian EPU is about 8%. Looking at booms, Canadian EPU explains an even lower share of the U.S. EPU (about 4%), which is instead mostly explained (about 70% of total volatility) by its own shock.[23] Differently, the contribution of U.S. EPU innovations to the volatility of the Canadian EPU index is 32% in busts and 30% in booms. This information is consistent with Granger causality tests conducted with a linear bivariate framework modeling the two EPU indices.[24] These tests point, on the one hand, to the rejection of the null of causality running from the Canadian EPU index to the U.S. one (p-value: 0.00), and on the other hand to the impossibility of rejecting, at any conventional levels, the causality running from the U.S. EPU index to the Canadian one (p-value: 0.36). This result supports a novel reading of the role of big countries like the U.S. as regards the dynamics of small neighboring countries like

[23]Notice that here we are referring to the volatility of the EPU indeces, not to that of the innovations to such indeces. Such innovations, which are those we use to compute the GIRFs documented in the previous Section and the FEVD reported in this Section, are exogenous under the assumption of our VAR being rich enough from an informational standpoint.

[24]We model a linear VAR(6) as suggested by the Akaike lag-length criterion.

Canada. Small open economies like Canada can be affected not only via the already well-known effects related to first-moment shocks like variations in technology or changes in macroeconomic policies, but also via a novel contagion channel which hinges upon second moments.

It is of interest to compare the contribution of uncertainty shocks to those of monetary policy shocks. Table 2 clearly points to a much smaller role played by monetary policy shocks as regards unemployment, with a contribution of about 6% during downturns (one fourth compared to external uncertainty shocks) and about 4% in booms (vs. 10% by U.S. EPU shocks'). The contribution of monetary policy shocks to the volatility of inflation reads 15% in busts and 14% in booms, and it is larger than that of uncertainty shocks, above all during expansions. Interestingly, the overall contribution of uncertainty shocks to the dynamics of the real exchange rate in busts is about 37%, much larger than the 5% due to monetary policy shocks. This gap is much smaller in booms, with the former shocks being responsible for about 12% of the variance of the real exchange rate against a contribution of about 3% by monetary policy shocks. Not surprisingly, the main driver of the short-term interest rate is monetary policy shocks. All in all, our results clearly point to uncertainty shocks (both external and domestic) as relevant drivers of the Canadian business cycle, at least when compared to monetary policy disturbances. Finally, it is important to check if our results are robust to the controls we employed to produce the GIRFs documented in Figure 5. Following Baker, Bloom, and Davis (2016), we take the model embedding the broad definition of Economic Uncertainty as a reference. Table 2 documents the contribution of the U.S. EPU shocks to the volatility of the variables in our baseline vector conditional on the EU control. Not surprisingly, the figures corresponding to this scenario point to a more limited role played by U.S. EPU shocks for the volatility of the Canadian unemployment rate. However, such contribution is still as large as 12% in busts, while it is a sixth of it (2%) in booms. This exercise suggests two things. First, that U.S. EPU shocks are likely to be a composite of pure policy-related uncertainty shocks and more general economic uncertainty shocks in models that do not feature a broader measure of uncertainty, like the EU indicator. Second, that our results still hold when this control is added to our baseline vector. Importantly, our Appendix shows that our main results are robust across all the different models discussed above. The remainder of the discussion on the U.S.-Canada analysis will refer to the model with the EU index as a control.

Transmission mechanism. The results of our FEVD analysis point to the possibility of an "international EPU spillover channel" linking the United States and Canada. In particular, one can conjecture the former country to be a big player whose economic policy uncertainty may lead neighboring countries like Canada to record subsequent increases in domestic uncertainty, and via this channel affect domestic business cycle indicators.[25] Indeed, a simple regression of the Canadian uncertainty index on a constant and lagged U.S. EPU returns an adjusted R^2 of 0.33, a signal of high predictive power of the U.S. EPU index on the Canadian counterpart. The conjecture that fluctuations in uncertainty occurring in the U.S. foster uncertainty in Canada is confirmed by the impulse response of the Canadian economic policy uncertainty to a shock to the U.S. EPU index obtained with our STVAR model. Figure 6 plots the response of the Canadian EPU index to a U.S. EPU shock. The Canadian index significantly increases. This gives us a broader picture of the effects of a shock to the level of U.S. economic policy uncertainty on Canada: a U.S. policy uncertainty shock triggers both an increase in Canadian policy uncertainty *and* a temporary downturn of real activity. One possible way to interpret these facts is that spikes in uncertainty in the U.S. exert a contemporaneous impact on a number of variables in Canada, Canadian uncertainty included. Another interpretation is that spikes in the U.S. level of uncertainty affect the level of Canadian economic policy uncertainty in first place and, because of that, they affect real activity.

We shed light on the role played by the Canadian EPU index *per se* by conducting a counterfactual scenario in which the Canadian EPU index does not react to systematic movements in the U.S. EPU index. If the economic policy uncertainty actually perceived and considered by the Canadian households and firms is the Canadian one, and not the U.S. one *per se*, what this counterfactual should produce is more moderate responses of the Canadian macroeconomic indicators to an U.S. EPU shocks with respect to the baseline ones.

Figure 7 shows that this is indeed the case, first and foremost for the unemployment rate. In recessions, this variable displays a much more moderate response in the counterfactual scenario in which the Canadian EPU index does not respond to movements in U.S. EPU. Industrial production drops quickly, it immediately rebounds after the drop, and it displays a less pronounced overshoot. Also the counterfactual inflation and the nominal interest rate are characterized by realizations much closer to zero in

[25] Given its interconnections with the United States, a country which would offer relevant information to validate this hypothesis is Mexico. Unfortunately, no EPU index for Mexico has been produced to date.

the medium run. We interpret this evidence as consistent with an "economic policy uncertainty spillovers channel" at work.

7 International analysis

The results obtained so far document a significant economic uncertainty spillover effect originating in the United States for the Canadian economy. It is of interest to investigate whether U.S. EPU shocks are important drivers of the business cycle in other countries too, not necessarily as much integrated with the U.S. as Canada is. For reasons explained below, we focus on the countries belonging to the G7 plus Brazil and estimate our nonlinear framework (1)-(3) to model the following country-specific data: $\mathbf{X}_t^i = [EPU_t^{US}, EPU_t^i, \overline{\Delta IP}_t^i, u_t^i, \pi_t^i, R_t^i, \Delta\epsilon_t^i]'$, where EPU_t^{US} is the U.S. EPU uncertainty index, while the remaining variables refer to a country $i \in \{$*Japan, U.K., Germany, France, Italy, Brazil* As in the previous Section, per each country i we model the country-specific uncertainty index EPU_t^i, the eighteen-term moving average of the monthly growth rate of industrial production (percentualized and annualized) $\overline{\Delta IP}_t$, the unemployment rate u_t^i, the CPI inflation rate π_t^i (y-o-y percentualized growth rate of the monthly index), the policy rate R_t^i, and the bilateral real exchange rate $\Delta\epsilon_t^i \equiv \pi_t^{US} + \Delta s_t^{iUS} - \pi_t^i$ constructed by considering the inflation rates in the two countries and combining it with Δs_t^{iUS}, which is the y-o-y growth rate of the country i/US nominal exchange rate.[26] We model the regime changes in the six countries we analyze (Japan, U.K., Germany, France, Italy, Brazil) by adopting the dating of the business cycle produced by the ECRI.

The samples employed for this international analysis are the following: U.K.: 1960M1-2014M10; Japan: 1988M1-2014M10; Germany, Italy, and France: 1987M1-2014M10; Brazil: 1994M7-2014:M10. The dating of the business cycle (booms/busts) is the one produced by the ECRI. The EPU indices constructed by Bloom et al. (2016) for Germany and Italy are available starting from, respectively, 1993M1 and 1997M1. We construct observations for these two countries from 1987M1 to the first available in Bloom et al.'s (2016) database by backcasting them on the basis of the European EPU

[26] The policy rate is the discount rate for the U.K, Germany, and Italy, and the call rate for France and Japan. The policy rate in Germany, Italy, and France is the Euro area rate in the period 1999-2014. All the series were downloaded from the Federal Reserve Bank of ST. Luis website, with the exception of the policy rate for Japan, which was downloaded from the Bank of Japan website, and the EPU indeces, which were downloaded from the website http://www.policyuncertainty.com/ . As regards the transition indicator for Italy, we experienced convergence problems when working with the eigheen-month moving average of industrial production. Convergence was achieved by working with the six-month moving average.

index available at http://www.policyuncertainty.com/ . The backcasting is conducted by running the regression $EPU_t^i = \alpha + \beta EPU_t^{EURO} + \varepsilon_t$ and then using the fitted values $\widehat{EPU}_t^i = \widehat{\alpha} + \widehat{\beta} EPU_t^{EURO}$ to construct the missing observations. The $\overline{R}^2$ of the regression modeling the German EPU is 0.73, while the one of the regression modeling the Italian one is 0.55. Finally, the EPU index for Brazil is available from 1991. However, we employ a shorter sample to avoid dealing with the hyperinflationary period previous to the introduction of the Brazilian Real in July 1994.

The choice of working with these countries is due to two data-related requirements. First, we need to model the country's EPU index to control for domestic uncertainty shocks and be sure that what we isolate is U.S. EPU spillover effects. Hence, the set of countries we consider is de facto limited by the number of countries covered by the policy uncertainty project developed by Scott Baker, Nicholas Bloom, and Steve Davis. At the moment (October 2016), these countries are fourteen, i.e., the U.S., Canada, U.K., Italy, France, Spain, Netherlands, China, India, Japan, Russia, South Korea, Australia, and Brazil (plus the Euro area as an aggregate). Within this set of countries, we include those with a a sample to be long enough so to have a) enough observations to estimate our multivariate model, and b) enough recessions to separately identify responses in booms/busts. As regards this last requirement, we follow Hansen (1999) and consider only countries with at least 10% of the observations in the sample associated to busts. Hence, we discard China, Australia, and South Korea due to an insufficient number of observations in busts (recessions) according to the ECRI.[27] The EPU index for the Netherlands is available from 2003M3, for India from 2003M1, and for Spain from 2001M1. We judge these samples as too short for a nonlinear analysis like ours, which is data-demanding because of the need of information to identify impulse responses in both regimes. Finally, we do not analyze Russia because of the numerous turbulences experienced in the 1990s. Such turbulences imply that one would need to conduct a nonlinear analysis while accounting for structural breaks, something which we leave to future research.

It is useful to recall that, according to the Observatory of Economic Complexity (OEC), 74% of Canadian total export was imported by the United States, and 55% of Canadian imports came from the United States in 2014. A much weaker trade-relationship took place in the same year between the U.S. and each of the G7 countries

[27] In the sample for which the EPU indeces for these countries are available, China and Australia are documented to have experienced no recessions, while for South Korea just 9.4% of the observations available are classified as recessionary.

we consider in this international analysis. U.K. exported to the United States about 11% of its total export, and its import originated in the U.S. amounted to 6.7%. Japan's export to the U.S. represented 18% of the country's total export, while the share of import from the United States was just 9%. Germany's export to the U.S. represented 8.6% of its total export, and 5.4% of its total import. Italy's trade exchanges with the U.S. accounted for 8% of its export and 3.5% of its import. France's trade relationship with the U.S. accounted for 7% of its total export and 6% of its total import, while Brazil's accounted for 12% of its exports and 15% of its imports. These figures depict a strikingly different picture in terms of trade-relationships with the United States with respect to the Canada-U.S. one. Hence, if the U.S. EPU shocks do not exert any effects on these countries' unemployment rates, one could infer that the trade channel is actually the relevant one via which such shocks are transmitted. Differently, a significant response of unemployment in these countries would suggest that an "uncertainty channel" *per se* is at work.

Figure 8 plots the response of unemployment to a one-standard deviation shock in U.S. EPU in booms (here, expansions according to the ECRI) and busts (ECRI recessions) for each of these six countries. Our main message turns out to be robust to this international analysis. In particular, the unemployment rate is found to react significantly and nonlinearly to U.S. EPU shocks, with a much stronger response in recessions. In terms of magnitude, the weakest response to a U.S. EPU shock is that of the Japanese unemployment rate. This is interesting, because Japan, among the six countries considered in this international analysis, is the one featuring the most intense trade-relationship with the United States. Hence, we see our results as supporting the idea of an "uncertainty channel" transmitting jumps in U.S. uncertainty to G7 countries' and Brazil's real activity via an increase in domestic economic policy uncertainty.

8 Conclusions

We investigate the spillover effects of a jump in U.S. economic policy uncertainty for the Canadian business cycle. Using a nonlinear (Smooth-Transition) VAR, we find that such effects are present, significant, and asymmetric over the Canadian business cycle. In particular, our empirical model points to a strong evidence of spillovers in busts, and much less so in booms. The macroeconomic responses in these two states are found to be different from a statistical and economic standpoint. Counterfactual simulations conducted by freezing the response of the Canadian economic policy uncertainty index to U.S. EPU signal the existence of an "economic policy uncertainty spillover channel", i.e., spikes in U.S. economic policy uncertainty foster uncertainty in Canada and, via this channel, lead to a temporary slowdown of Canada's real activity. Finally, an international analysis involving the remaining G7 countries plus Brazil confirms that U.S. EPU shocks are likely to be among the drivers of unemployment when bad times are in place. Our empirical findings support the conclusions of previous empirical studies documenting the asymmetric behavior of the unemployment rate along the business cycle (Koop and Potter (1999), Dibooglu and Enders (2001), van Dijk, Teräsvirta, and Franses (2002), Morley and Piger (2012), and Morley, Piger, and Tien (2013)), and to contributions pointing to the asymmetric business cycle effects of uncertainty shocks (Alessandri and Mumtaz (2014), Nodari (2014), Caggiano, Castelnuovo, and Groshenny (2014), Caggiano, Castelnuovo, and Nodari (2015), and Caggiano, Castelnuovo, and Figueres (2016)).

From a policy perspective, our evidence suggests that uncertainty about future policy actions in influential countries like the U.S. may be costly not only for such countries but can importantly spillover on to small-open economies like Canada. As discussed by Davis (2015), the large increase in the number of norms and regulations that the U.S. economy has experienced for several years now is likely to have increased the level of policy-related uncertainty. Davis (2015) and Baker, Bloom, and Davis (2016) call for a clear, simple, and easy to manage regulatory system, a simple tax system, and predictable, timely, and clearly communicated policies. Thinking of the advantages of having economically sound commercial partners, our results suggest that the pay-off for the U.S. of implementing the policies suggested by Davis (2015) and Baker, Bloom, and Davis (2016) may be larger than those typically estimated when considering the U.S. case in isolation.

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Date	Event	Baseline	Dummy
Oct. 1987	Black Monday	X	X
Jan. 1991	Gulf War I	X	
Nov. 2000	Bush election	X	X
Sep. 2001	9/11	X	X
Mar. 2003	Iraq invasion	X	
Jan. 2008	Large interest rate cuts	X	X
Sep. 2008	Lehman Brothers' bankruptcy	X	X
Oct. 2008	Global Financial Crisis	X	
July 2010	Mid-term elections	X	X
Sep. 2010	Mid-term elections	X	X
July 2011	Debt Ceiling	X	X
Aug. 2011	Debt Ceiling	X	X
Nov. 2012	Fiscal cliff	X	X
Oct. 2013	Government shutdown	X	X

Table 1: **Major U.S. and Global Economic Policy Uncertainty Shocks.** Baseline: Dates corresponding to positive realizations of the estimated shocks exceeding 2 standard deviations according to our baseline model. Dummy: Dates selected by focusing on domestic (U.S.) events only.

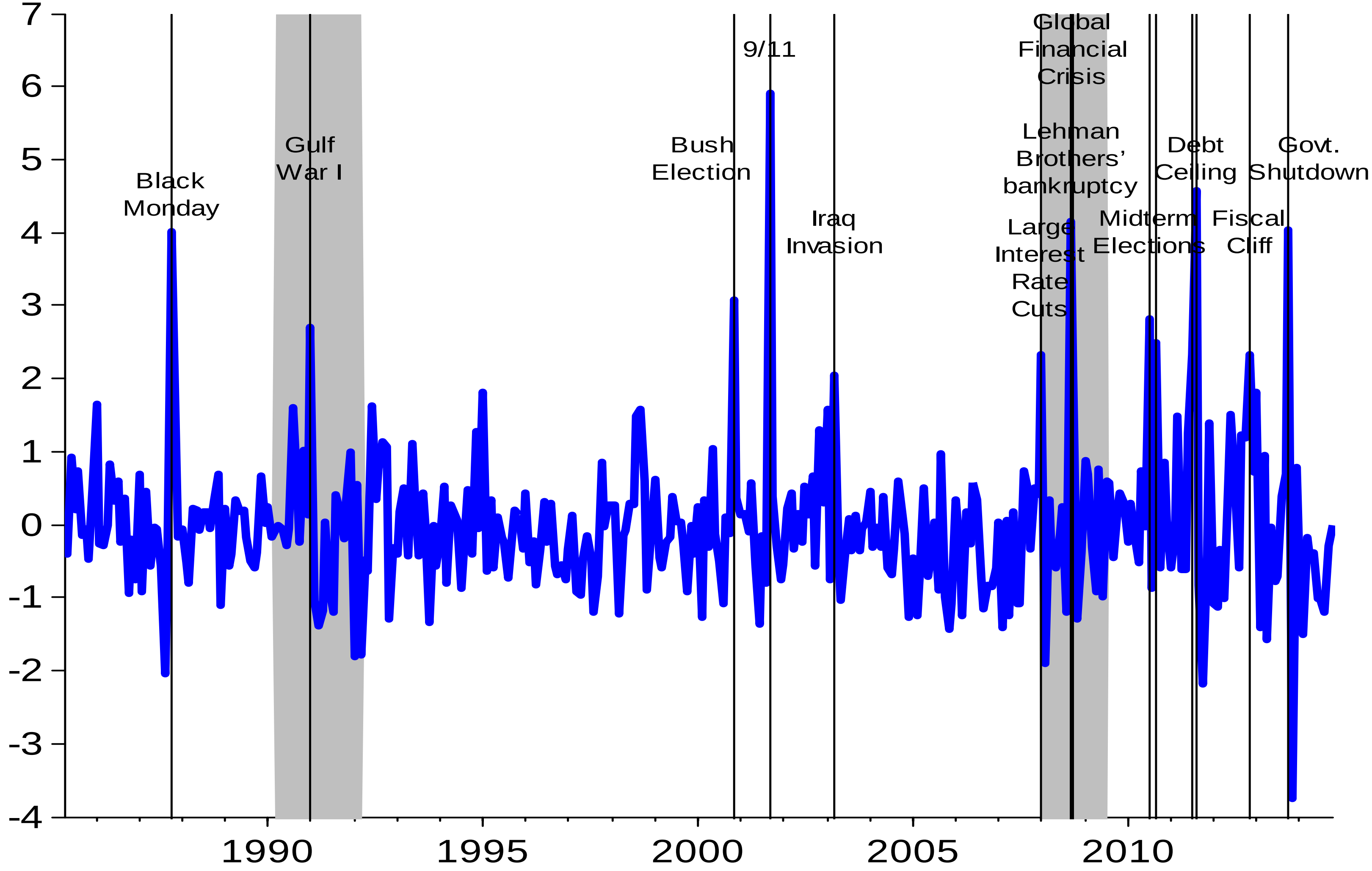

Figure 1: **U.S. EPU shocks**. Blue line: U.S. EPU shocks estimated with the U.S.-Canada STVAR as explained in the text. Black vertical lines: Realizations of the shock larger than two standard deviations. Grey vertical bars: Canadian recessions as dated by the ECRI.

	Busts							
Shock/Variable		EPU_t^{US}	EPU_t	ΔIP_t	u_t	π_t	R_t	$\Delta\epsilon_t$
$\widetilde{\varepsilon}^{EPU_t^{US}}$		0.63	**0.32**	0.08	**0.24**	0.14	0.18	0.15
$\widetilde{\varepsilon}^{EPU_t}$		**0.08**	0.36	0.14	**0.23**	0.10	0.14	0.21
$\widetilde{\varepsilon}^{R_t}$		*0.04*	*0.06*	*0.09*	*0.06*	*0.15*	*0.49*	*0.05*
$\widetilde{\varepsilon}^{EPU_t^{US}}$	*EU*	0.34	**0.15**	0.03	**0.12**	0.08	0.05	0.05

	Booms							
Shock/Variable		EPU_t^{US}	EPU_t	ΔIP_t	u_t	π_t	R_t	$\Delta\epsilon_t$
$\widetilde{\varepsilon}^{EPU_t^{US}}$		0.70	**0.30**	0.03	**0.10**	0.04	0.07	0.05
$\widetilde{\varepsilon}^{EPU_t}$		**0.04**	0.42	0.05	**0.07**	0.06	0.10	0.07
$\widetilde{\varepsilon}^{R_t}$		*0.02*	*0.04*	*0.08*	*0.04*	*0.14*	*0.58*	*0.03*
$\widetilde{\varepsilon}^{EPU_t^{US}}$	*EU*	0.31	**0.08**	0.01	**0.02**	0.02	0.02	0.01

	Linear							
Shock/Variable		EPU_t^{US}	EPU_t	ΔIP_t	u_t	π_t	R_t	$\Delta\epsilon_t$
$\widetilde{\varepsilon}^{EPU_t^{US}}$		0.88	**0.35**	0.02	**0.17**	0.05	0.09	0.06
$\widetilde{\varepsilon}^{EPU_t}$		**0.02**	0.55	0.04	**0.07**	0.07	0.12	0.06
$\widetilde{\varepsilon}^{R_t}$		*0.01*	*0.03*	*0.06*	*0.05*	*0.12*	*0.67*	*0.01*
$\widetilde{\varepsilon}^{EPU_t^{US}}$	*EU*	0.45	0.15	0.01	0.02	0.01	0.02	0.00

Table 2: **Forecast Error Variance Decomposition: U.S. vs. Canadian EPU Shocks.** 2 year-ahead forecast error variance decomposition. The figures reported in the table refer to the point estimates of the baseline model, with the exception of those in the fourth line of each case (Busts, Booms, Linear), which refer to the model with the Economic Uncertainty measure placed after the U.S. EPU index in the vector.

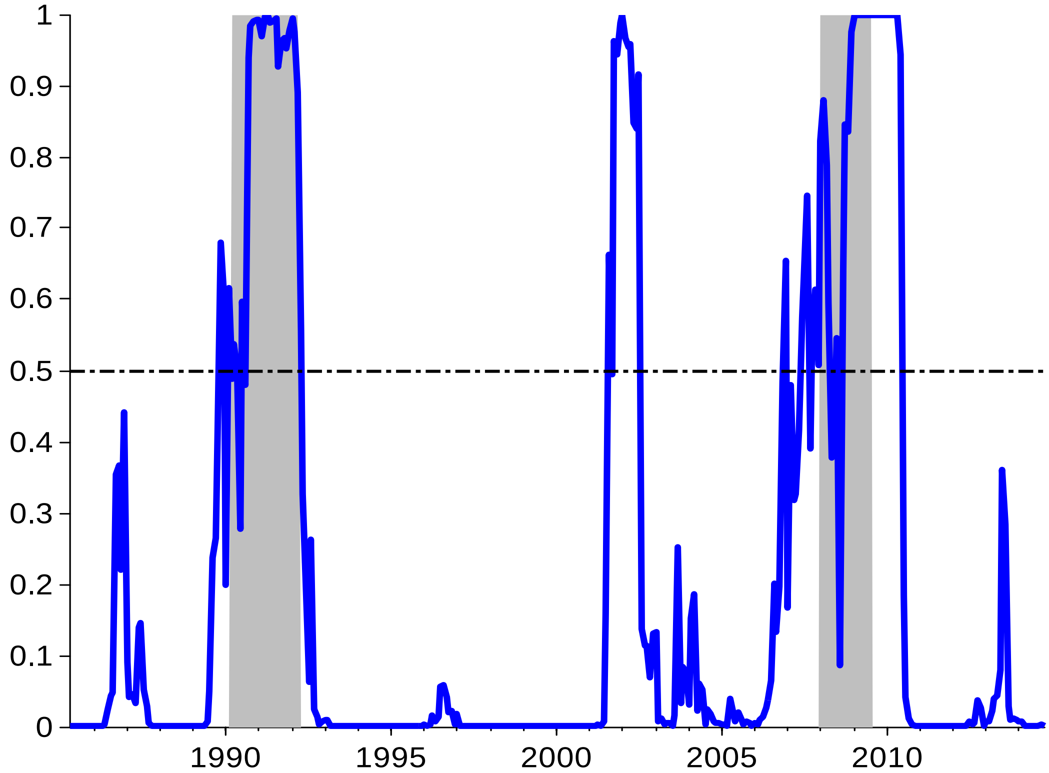

Figure 2: **Probabilities of Economic Booms for Canada as Estimated by the STVAR model.** Sample: 1985:M1-2014:M10**.** Function [1-F(z)] estimated jointly with the STVAR, baseline version with the U.S. EPU index. Transition indicator z: Moving average of the month-to-month growth rate of the Canadian industrial production comprising eighteen terms. Grey vertical bars indicate recessions as dated by the Economic Cycle Research Institute.

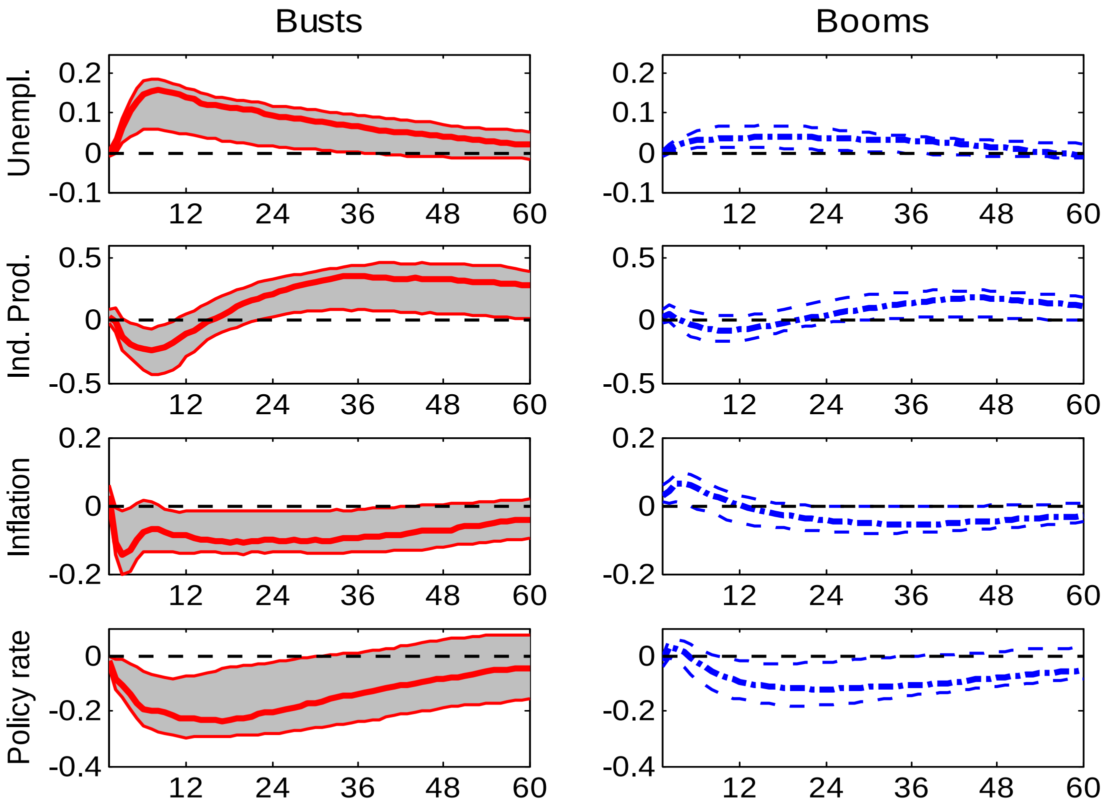

Figure 3: **Effects of a Shock to the U.S. EPU Index on the Canadian economy.** Sample: 1985:M1-2014:M10. Generalized median impulse responses to a one-standard deviation shock to the U.S. EPU index hitting the Canadian economy in busts (red solid line) and booms (blue dashed-dotted line). 68% confidence intervals identified via shaded areas (busts) and dashed blue lines (booms). Transition indicator for Canada: 18-term moving average of the monthly growth rate of the Canadian industrial production.

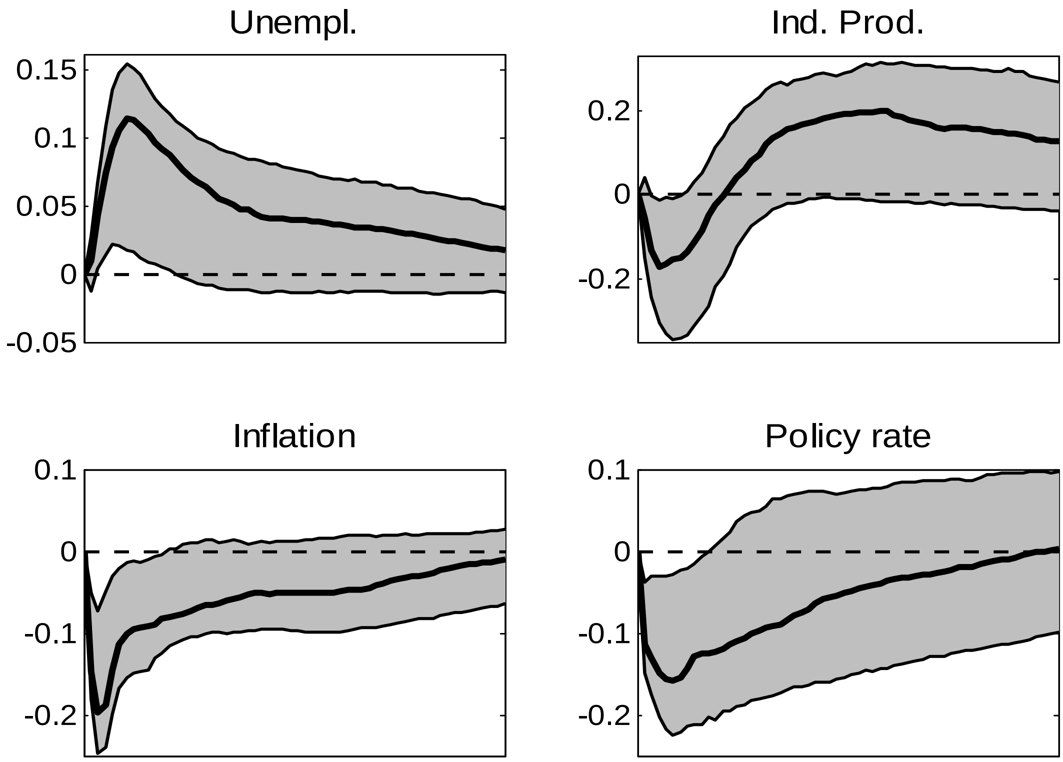

Figure 4: **Effects of a Shock to the U.S. EPU Index on the Canadian economy: Difference between states.** Sample: 1985:M1-2014:M10. Differences between generalized median impulse responses in busts and booms to a one-standard deviation shock to the U.S. EPU Index. Median realizations identified via black lines, 68% confidence intervals identified via shaded areas. Transition indicator for Canada: 18-term moving average of the monthly growth rate of the Canadian industrial production.

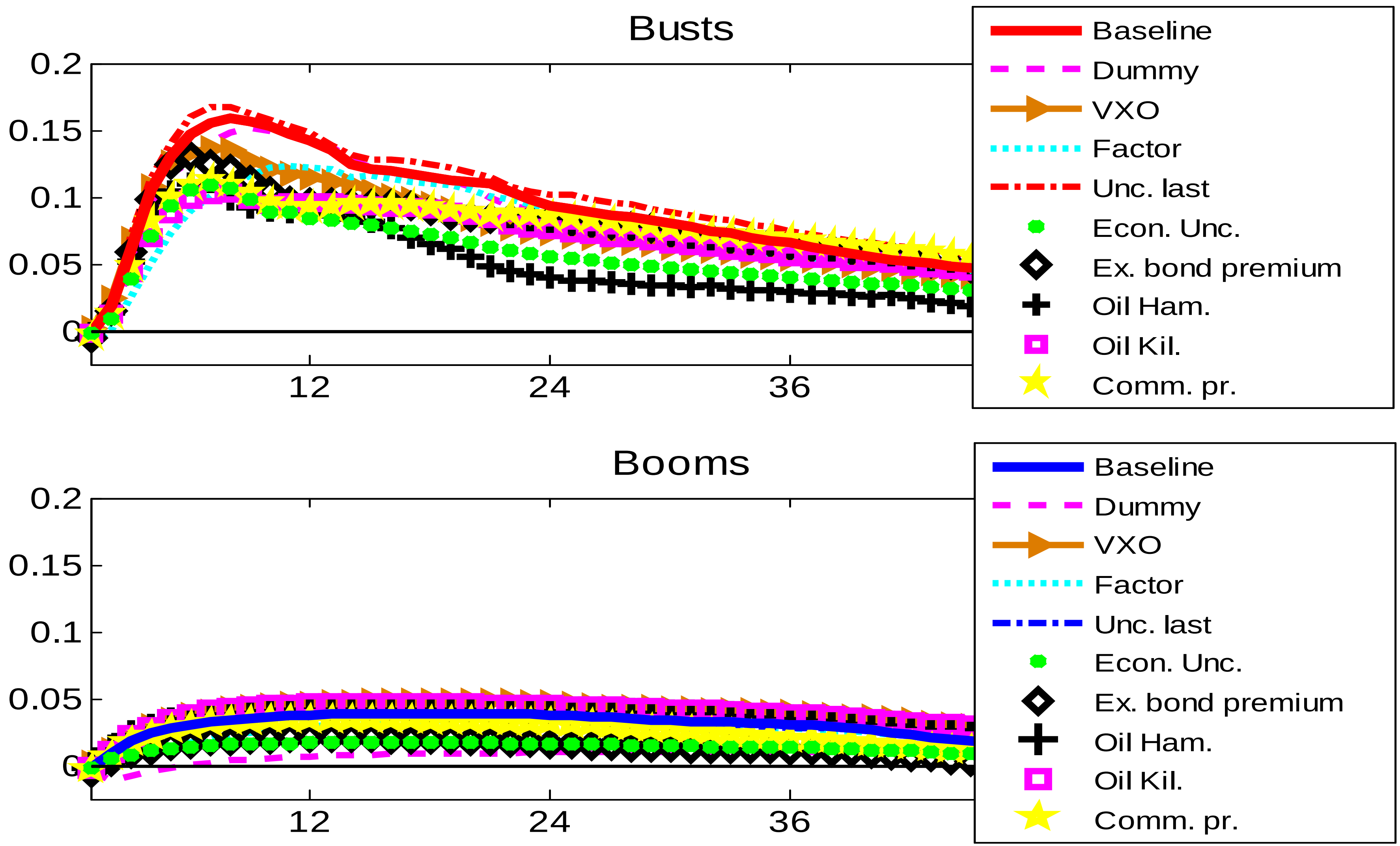

Figure 5: **Response of the Canadian unemployment rate to an EPU shock originating in the U.S.: Robustness checks**. Responses of Canadian unemployment to a one standard deviation U.S. EPU shock for the models discussed in Section 5.

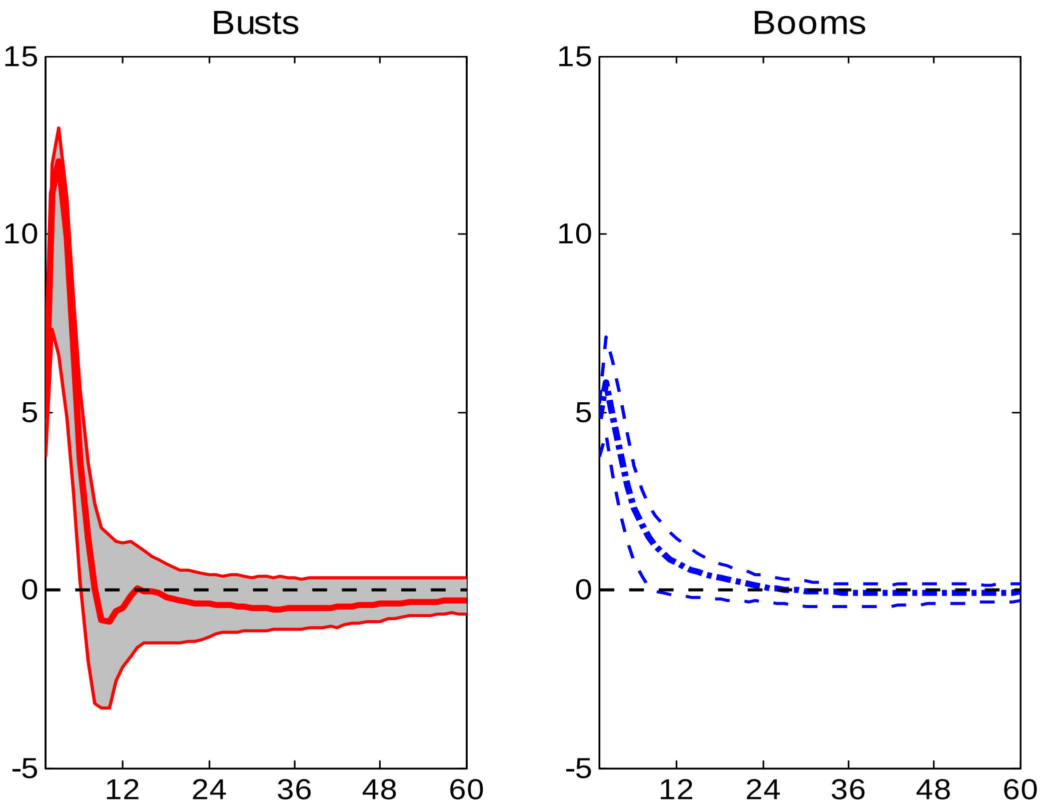

Figure 6: **Response of Canadian EPU to U.S. EPU shocks**. Sample: 1985:M1-2014:M10. Generalized impulse responses to a one-standard deviation shock to the U.S. EPU index hitting the Canadian economy in booms and busts. Transition indicator for Canada: 18-term moving average of the monthly growth rate of the Canadian industrial production. Model featuring Economic Uncertainty placed second in the vector as a control.

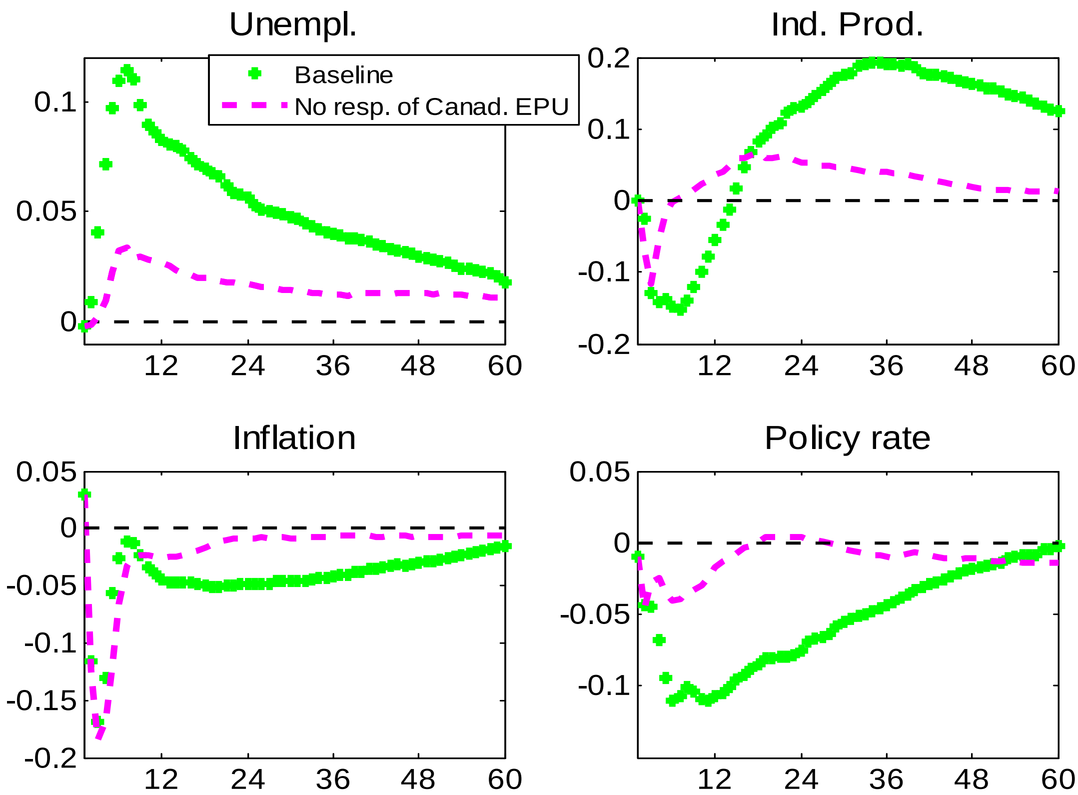

Figure 7: **Effects of a Shock to the U.S. EPU Index on the Canadian economy: Role of the Uncertainty Channel.** Sample: 1985:M1-2014:M10. Generalized impulse responses to a one-standard deviation shock to the U.S. EPU index hitting the Canadian economy in booms and busts. Counterfactual simulations termed "No resp. of Canad. EPU" conducted by zeroing the coefficients related the Canadian EPU index to the U.S. EPU index in the equation modeling the former variable. Transition indicator for Canada: 18-term moving average of the monthly growth rate of the Canadian industrial production. Model featuring Economic Uncertainty placed second in the vector as a control.

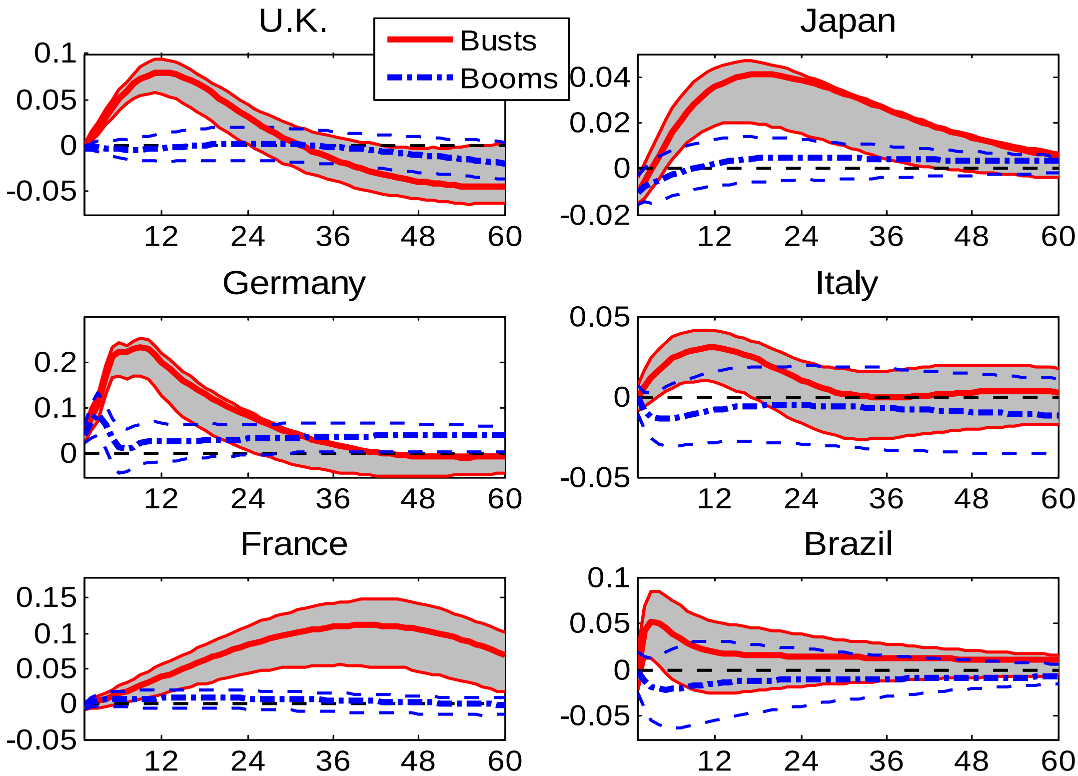

Figure 8: **International Analysis: G7 countries plus Brazil.** Samples (due to the availability of the country-specific EPU indeces): U.K.: 1960M1-2014M10; Japan: 1988M1-2014M10; Germany, Italy; France: 1987M1-2014M10; Brazil: 1994M7-2014:M10. Dating of the business cycle (booms/busts) by the ECRI. The EPU indeces contructed by Bloom et al. (2016) for Germany and Italy are available starting from, respectively, 1993M1 and 1997M1. Observations for these two countries from 1987M1 to the first available observations were constructed by backcasting them on the basis of the European EPU index available at http://www.policyuncertainty.com/ .