Global Uncertainty and International Business Cycles

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Abstract

We document that global uncertainty not only has significant impact on the business cycle but the impact goes beyond the usual output-depressing effect widely discussed in the literature. In addition, we find that countries are heterogeneously exposed to global uncertainty and the response of macro variables to global uncertainty shocks differs across levels of exposure.

1. Introduction

The literature in the effects of macroeconomic uncertainty in the business cycles has grown considerably in recent years. In this paper, we document that global uncertainty not only has significant impact on the business cycle but the impact goes beyond the usual output-depressing effect widely discussed in the literature.

The uncertainty literature has provided important insights in how aggregate uncertainty can have deleterious effects on economic activity. Bernanke (1983), one of the earliest contributions in the field, argued that higher uncertainty in the presence of capital irreversibilities cause firms to postpone investment in physical capital until uncertainty is resolved. Bloom (2009) showed that economic activity significantly declines in the aftermath of uncertainty-triggering events and proposed a general equilibrium framework in which firms face real rigidities (capital and labor partial irreversibilities, investment adjustmen costs) and freeze investment and hiring decisions. Jones et al. (2005) found that uncertainty might actually lead to higher average growth rates. Justiniano and Primiceri (2008) highlight that time-varying volatility considerably improves the adequacy of DSGE models to the data.

More recently, the role of macroeconomic uncertainty in open-economy settings has also been the subject of important contributions to the literature. Novy and Taylor (2014) docu-

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ment that international trade significantly falls when uncertainty is high due to a disproportionate decline in the demand for foreign capital goods. Colacito et al. (2015), on the other hand, focus on the transmission of volatility shocks across countries and its implications to quantity and prices.

We also focus on the open-economy effects of uncertainty shocks but, unlike Novy and Taylor (2014), we abstract from investment and, naturally, the demand for capital goods. We document that even in the absence of the most sensitive component of output to business conditions, uncertainty has significant effects on the business cycle. More interestingly, the impact of uncertainty on consumption and international trade is significant even when output is not in a recession.

We consider a common source of risk across countries, which we refer to as global uncertainty, and empirically establish a link between global uncertainty and business cycle dynamics. We show that in spite of the fact that global uncertainty shocks hit all countries simultaneously, their impact is not homogeneous across countries. The heterogeneity in the cross-country exposure to global uncertainty enables countries to share global risk and attain a smoother consumption profile. The next step in this research project is to design an economic model that replicates the dynamics observed in the data.

The paper is organized as follows: Section 2 describes the different approaches to measuring uncertainty. Section 3 describes the data. Section 4 explains how we measure global uncertainty and the country-specific exposures to it. Section 5 contains the empirical results.

2. Measuring macroeconomic uncertainty

Several proxies for the uncertainty level have been proposed in the literature. Stock market volatility (Bloom (2009) and Ludvigson et al. (2015)), disagreement among professional forecasters Colacito et al. (2016), cross-sectional volatility of firms' earnings (Gilchrist et al., 2014), and news-based uncertainty indices (Baker, Bloom, and Davis, 2016) are some of the most widely known measures of uncertainty. All these measures face the challenge of informing about the underlying uncertainty level in the economy, which is a latent state variable, while not being confounded with other factors. Put differently, all proxies will be noisy measures of the uncertainty level but some have desirable properties that make them more appropriate in the context of this paper.

The adequacy of the stock market volatility as a proxy for uncertainty relies on the ability of stock prices to reflect the state of the economy and the level of disagreement about the perceived state. If agents disagree about the state of the economy then volatility rises and correctly informs about the level of uncertainty. Unfortunately, stock price volatility may rise or fall for other reasons than the changes inf the level of macroeconomic uncertainty and it is hard to disentangle the movements in stock price volatility that are caused by macroeconomic fundamentals from those that are not. In addition, our sample is composed by 20 countries with different market structure - rules, transparency, market cap as % of GDP - so cross-country comparisons based on stock price volatility may be contaminated by the heterogeneity in the market structure.

In this sense, a survey of professional forecasters on their expectations about the state of the economy seems more appropriate since the only source of disagreement is uncertainty about the state of the economy itself. Also, forecasters are forward-looking, unlike the cross-sectional volatility of firms' earnings, and help agents make hiring and investment decisions today. In fact, the decline in employment and investment caused by a rise in uncertainty is the core of the real-options literature (Bernanke, 1983). Unfortunately, there is no consistent survey for all the countries in our sample (same questions, frequency, etc).

The news-based uncertainty index proposed by Baker et al. (2016) consists on the adjusted[1] number of newspaper articles that contain terms related to economic uncertainty.

[1]A detailed description of the index is available in Section 3.

The index simplicity is a desirable feature since the same procedure can be applied to different countries and the resulting series are country-specific realizations of the same measure, which makes cross-country comparisons a natural exercise. In addition, the media coverage of economic events realistically reflects the information set available to the average agent at the time of their decision on consumption, savings, hiring and investment. In other words, even if the professional forecasters survey were a more accurate prediction of the current and future states of the economy, the typical agent may not have access to such forecasts while large circulation newspapers are a readily available and inexpensive source of information.

The model-free nature of the news-based index is also appealing from an econometric perspective. First, suppose we could estimate a conditional volatility process for each country's output. Then the filtered volatility in, say, the first quarter of 2005 is obtained with information that arrived after 2005 since the parameters were estimated with data for the whole sample period. Hence, the response of macroeconomic variables to such measure of uncertainty would be incorrect because the agents did not have access to that information at the time of their decision. A second desirable consequence of a model-free uncertainty measure is that it naturally accommodates structural breaks. Regime changes are difficult to treat econometrically because the time of the structural break might be unknown and short samples like ours may cause the statistical test to lack the power to reject a "no-regime-switch" hypothesis. Since our sample includes countries with very diverse institutional frameworks, it is important that the uncertainty measure is not conditional on the regime. For these reasons, we will use the index constructed by Baker et al. (2016) as the measure of uncertainty throughout this paper.

3. Data

The sample consists of quarterly data on Australia, Brazil, Canada, Denmark, France, Germany, Greece, India, Italy, Japan, Korea, Holland, Norway, Poland, Spain, Sweden, Switzerland, Turkey, UK and United States. All macroeconomic variables are measured in real terms and extracted from OECD website. Data availability, however, varies across countries and time series for the emerging countries are usually shorter. Data for Brazil and India, for example, range from 1996Q1 to 2016Q2. Time series for Greece, Korea, Poland and Turkey are as long as for developed countries.

The macroeconomic variables considered in this manuscript are output and consumption per capita, real exchange rate, exports and imports. The economic model to be developed in the future assumes endowment economies and, for that reason, we abstract from investment and government consumption. Hence, output is defined as private consumption plus trade balance.

The uncertainty level is measured by the news-based index proposed by Baker et al. (2016). The index consists of a monthly count of newspaper articles that contain economic uncertainty related terms. The raw count is then scaled by the total number of articles published by each newspaper so the positive trend in the number of newspaper articles is accounted for. The scaled count is then standardized to have mean 100 and unit standard deviation prior to 2011.

The U.S. and Canada series start in 1985 and France starts in 1987. The uncertainty index series for all other countries start after 1990 so we constrain our sample for all countries to the 1990-2016 period. Also, we use the aggregate European uncertainty series for countries that do not have a specific series (Denmark, Greece, Norway, Poland, Sweden, Switzerland and Turkey). Some emerging countries have shorter samples, for example, India series start in 2003. Brazil and Korea have data since 1991 and 1990, respectively.

Table 1 shows the correlation between U.S. and local uncertainty levels. Note they vary considerably across countries but no clear pattern emerges from the correlations alone. In fact, the correlation between U.S. and Australia uncertainty levels is higher than those of U.S. and Canada.

Despite the variation across countries, the correlations are fairly high in a general sense.

Developed						
Australia	Canada	Denmark	France	Germany	Italy	Japan
0.83	0.69	0.71	0.54	0.64	0.56	0.43
Holland	Norway	Spain	Sweden	Switzerland	UK	
0.53	0.71	0.65	0.71	0.7	0.63	

Emerging					
Brazil	Greece	India	Korea	Poland	Turkey
0.39	0.71	0.67	0.6	0.8	0.7

Table 1: Correlation between U.S. and local uncertainty levels.

Note that a significant portion of the comovements in uncertainty may be due to a global component that hits all countries simultaneously. In this sense, we can view the global component of uncertainty as a common risk factor to which countries are exposed. If the exposure is homogeneous across countries then a rise in global uncertainty is a nondiversifiable source of risk. On the other hand, if the exposure to global uncertainty is heterogeneous across countries then there may be room for risk sharing and potential welfare gains from a smoother consumption profile.

Section 4 explains the construction of the global uncertainty measure and country-specific exposure to it and Section 5 documents the estimated effects of global uncertainty on the business cycles.

4. The global uncertainty measure

The global uncertainty index is simply the cross-sectional GDP-weighted average of the countries' uncertainty indices. Our approach is similar to the global uncertainty index constructed by Baker et al. (2016), the main difference being that our output measure does not include investment and government consumption.

We then fitted an $AR(1)$ specification to the log-transformed series and found that global uncertainty is highly persistent, with an estimated autoregressive coefficient of 0.69 at the quarterly frequency (roughly 0.88 at the monthly frequency). These estimates imply that an uncertainty shock lasts three quarters on average, which is compatible with Bloom (2009) calibration based on U.S. data.

Note that the residuals from the projection of global uncertainty on its lag are the innovations on global uncertainty, that is, the component of uncertainty that cannot be forecasted. To make sure there is no leftover forecastability in the innovations, we performed a Ljung-Box test with 6, 12, 18 and 24 lags and could not reject the hypothesis of no autocorrelation (p-values are 0.13, 0.37, 0.19 and 0.36 respectively). From a purely statistical perspective, our global uncertainty shocks are indistinguishable from a white noise process.

There is, however, an intense debate on whether or not uncertainty is endogenous to the business cycles Ludvigson, Ma, and Ng (2015). It is well documented that uncertainty is higher in bad times the direction of causality seems to be far from a consensus. To address this potential issue, we test if macroeconomic fundamentals have predictive power on our global uncertainty innovations series.

In the spirit of Evans (1992), we estimate the regression

$$\varepsilon_t^{global} = a(L)\varepsilon_t^{global} + b(L)\Delta\, y_t^w + c(L)\Delta\, c_t^w + u_t$$

where ε_t^{global} is the global uncertainty shock at time t, $\Delta\, y_t^w$ and $\Delta\, c_t^w$ are GDP-weighted average output and consumption growth in per-capita terms. Four lags are considered for $a(L)$, $b(L)$ and $c(L)$. The hypothesis that $a(L) = b(L) = c(L) = 0$ is not rejected (p-value $= 0.77$). Hence, we find no evidence that our global uncertainty shocks are endogenous to the global business cycle.

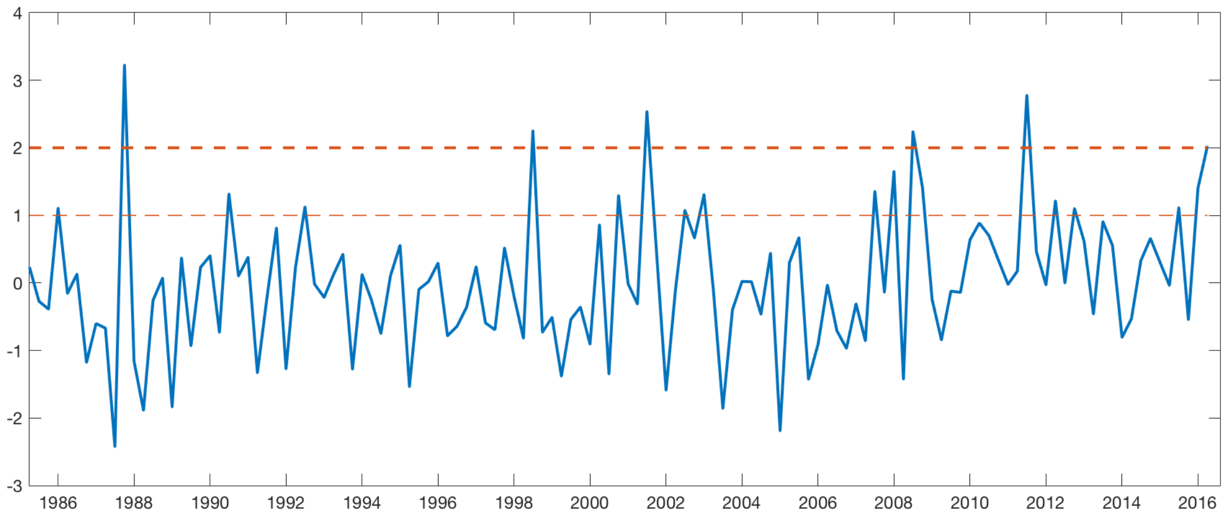

Figure 1: Standardized global uncertainty shocks. Noteworthy events are "Black Monday" in 1987, Asian crisis in 1998, 9/11/2001, the financial crisis in 2008, Euro area crisis in 2011 and Brexit in 2016.

4.1. Heterogeneous exposure to global uncertainty shocks

To assess the exposure of country-specific uncertainty to global uncertainty shocks correctly we must ensure that the endogenous component in local uncertainty is removed. Note that in addition to the business cycle variables, global factors other than global uncertainty might influence uncertainty at the country level.

Consider the projection of the local uncertainty index onto lags of output and consumption growth, government consumption as share of GDP, inflation, commodities and oil prices. It is the portion of local uncertainty forecastable from local and global factors and the residuals from such projection are, naturally, the portion of local uncertainty that cannot be forecasted. We will refer to these residuals as the country-specific uncertainty shocks throughout the paper.

We compute the exposure of country-specific uncertainty shocks to global uncertainty shocks through the regression

$$\varepsilon_{it}^{u} = \beta_i \, \varepsilon_t^{global} + v_{it}$$

where ε_{it}^{u} is country i's uncertainty shock at time t and β_i is the level of exposure to global uncertainty shocks. The estimated β_i's are displayed in Table 2.

High					
UK	Spain	U.S.	Denmark	Holland	
0.886	0.813	0.813	0.77	0.766	
(0.11)	(0.14)	(0.07)	(0.1)	(0.1)	
Switzerland	Norway	France	Germany		
0.747	0.729	0.726	0.717		
(0.09)	(0.09)	(0.11)	(0.13)		

Low					
Turkey	Greece	Sweden	Australia	Poland	Canada
0.695	0.693	0.685	0.642	0.619	0.609
(0.08)	(0.09)	(0.09)	(0.16)	(0.08)	(0.1)
Korea	Italy	Brazil	Japan	India	
0.576	0.508	0.44	0.379	0.234	
(0.11)	(0.09)	(0.12)	(0.08)	(0.1)	

Table 2: Estimated exposure of country-specific uncertainty shocks to global uncertainty shocks.

All exposures are positive and significant. Hence, when an uncertainty shock hits the system, uncertainty rises in all countries. However, the magnitude of the impact is not the same everywhere. For instance, the country with the highest exposure, the UK, is almost four times more exposed than India, the least exposed according to Table 2.

We choose the cutoff between the high- and low-exposure groups in a way that roughly splits the sample in half.

Now that we have the two groups assigned according to the level of exposure of local uncertainty to global uncertainty shocks, we can establish the link - if any - between global uncertainty and business cycle dynamics.

5. Empirical evidence

Most of the literature in uncertainty and its business cycles implications attempts to uncover the mechanisms through which fluctuations in the uncertainty level have real macroeconomic effects. The usual approach is to assume the existence of rigidities (partial irreversibility, adjustment costs, etc) in an uncertain economic environment so that second-moment shocks have first-moment effects (see **?** and Bloom (2009), for example).

This section documents that even when we abstract from investment - component of GDP most sensitive to business conditions - uncertainty shocks still play a significant role in the business cycles. Additionally, we verify that the nature of the response of macroeconomic variables to uncertainty shocks is consistent across different methods: vector autoregressions and local projections.

5.1. Macroeconomic effects of global uncertainty shocks: VAR evidence

The starting point in the estimation of the effects of global uncertainty in the economy is a first-order autoregression of the global uncertainty level, country-level output and consumption growth, and the growth of the trade balance as a share of GDP, in this order. Also, we choose a lower-triangular Cholesky identification strategy.

The left (right) panel of Figure 2 shows the response of output and consumption growth to a one standard deviation increase in global uncertainty in high (low) exposure countries. When the global uncertainty shock hits, output in highly exposed countries falls significantly and remains below steady state for the next six periods - except at the one period lag, at which the response is negative but not significant. Output in low-exposure countries does not fall significantly at any horizon.

Consumption , on the other hand, falls unambiguously in both groups. In the high-exposure group, consumption falls at the moment of the shock then slowly returns to steady state whereas the return to steady state in low-exposure countries occurs in the quarter following the shock. Two additional points are worth mention. First, the decline in consumption is significant even after five or six quarters, almost twice as long as the half-life of the uncertainty shock itself. Put differently, the effects of global uncertainty on consumption in highly exposed countries linger even after the global uncertainty shock itself has dissipated. Second, consumption does not temporarily rise above steady state as to

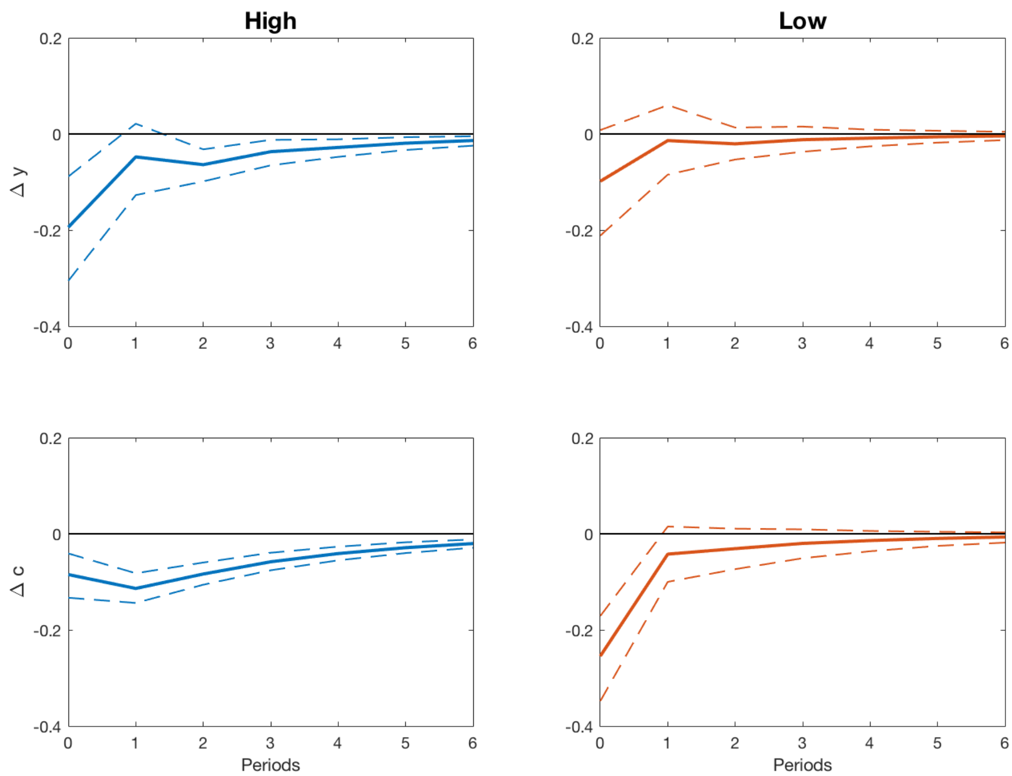

Figure 2: Response of output and consumption growth (per capita) to a global uncertainty shock. Left (right) panel shows the response in countries with high (low) exposure to global uncertainty.

revert the initial decline, which implies that the uncertainty shock has permanent effects on consumption.

The sharp and significant consumption decline in the low-exposure group indicates that the role of uncertainty in the business cycles may be more extensive than depressing output only. The right panel in Figure 2 shows that, unlike in the high exposure group, consumption declines even if output remains unchanged. Interestingly, when the uncertainty shock hits the system, the magnitude of the consumption drop in the low exposure group is larger than that of the highly exposed group.

Despite the fact that global uncertainty shocks hit all countries simultaneously, Table 2 shows that countries are not homogeneously affected. In this sense, countries may engage in foreign trade to mitigate the effects of global uncertainty on their consumption profile. More specifically, upon the realization of a bad shock - i.e, uncertainty rises - goods flow

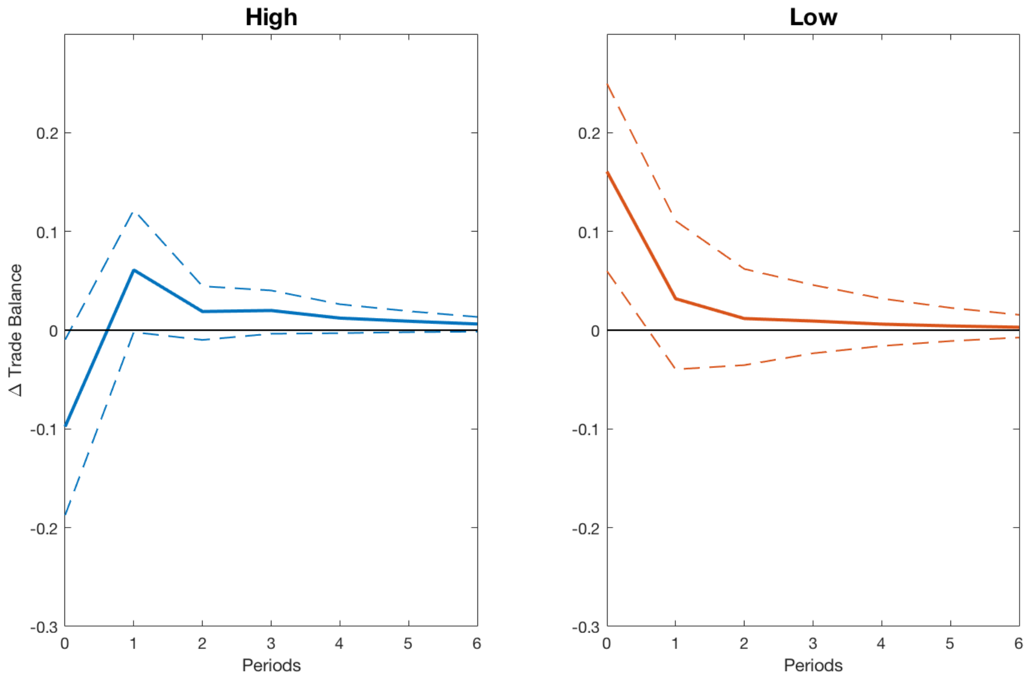

Figure 3: Response of trade balance to a global uncertainty shock. Left (right) panel shows the response in countries with high (low) exposure to global uncertainty.

from low- to high-exposure countries.

The response of the trade balance to a global uncertainty shock suggests that the risk-sharing mechanism is supported by the data. Figure 3 shows that countries in the high (low) exposure group experience a deterioration (improvement) in their trade balance when global uncertainty rises. Because we abstracted from investment and government consumption, the significant deterioration in the trade balance in highly exposed countries implies that the decline in consumption is significantly smaller than the decline in output. Hence, international trade significantly alleviates the welfare loss caused by global uncertainty.

Naturally, these results are conditional on the VAR(1) specification and, therefore, are correct only if the true data generating process is a first-order vector autoregression. In addition, the identification restrictions we imposed are not innocuous from an economic perspective. The lower-triangular Cholesky identification and the ordering we selected imply that uncertainty contemporaneously affects but is not affected by the other variables. Establishing the direction of causality in this context is an empirical challenge that has motivated the the works of Ludvigson et al. (2015), Jurado et al. (2015), to name a few. The goal of this paper, however, is not to argue whether uncertainty causes or is caused by recessions, but that uncertainty affects the business cycles even in the absence of recessions (see right panel of Figure 2).

Nevertheless, the assumption that the data generating process is a VAR might be too strong or simply wrong, so we consider a different approach to compute the response of business cycle variables to global uncertainty that does not assume the intrinsic recursiveness of the VAR.

5.2. Macroeconomic effects of global uncertainty shocks: evidence from local projections

The local projections approach (Jorda, 2005) to the esimation of impulse-responses is particularly convenient in the context of this paper because the timing identification restrictions we imposed are not consensual and we cannot test if the true dgp is a VAR.

The method consists on the projection of leads of variable of interest onto current and past values of control variables and current forecast error of the variable that generates the impulse. To better illustrate the procedure, the response of variable x_t at horizon h to global uncertainty shock ε_t^{global} is the coefficient γ_h from the projection

$$x_{t+h} = \gamma_h \, \varepsilon_t^{global} + controls + v_{t+h} \tag{1}$$

where the forecast error of global uncertainty is the residual from the $AR(1)$ estimated in Section 4.

Unlike the VAR case, in which the impulse-responses come from the corresponding Wold representation, impulse-responses via local projections require one regression for each horizon h, so the responses at different horizons are not imposed to be linear combinations of the same reduced-form parameters.

In addition to the more flexible econometric specification, the linear projections are not susceptible to misspecification biases induced by the identifying assumptions as in the VAR because the structural shocks are forecast errors were computed without any assumptions about the direction of causality.

The simple procedure described in Eq. 2 can be easily adapted to accommodate potential differences in the responses across groups. In the lines of Auerbach and Gorodnichenko

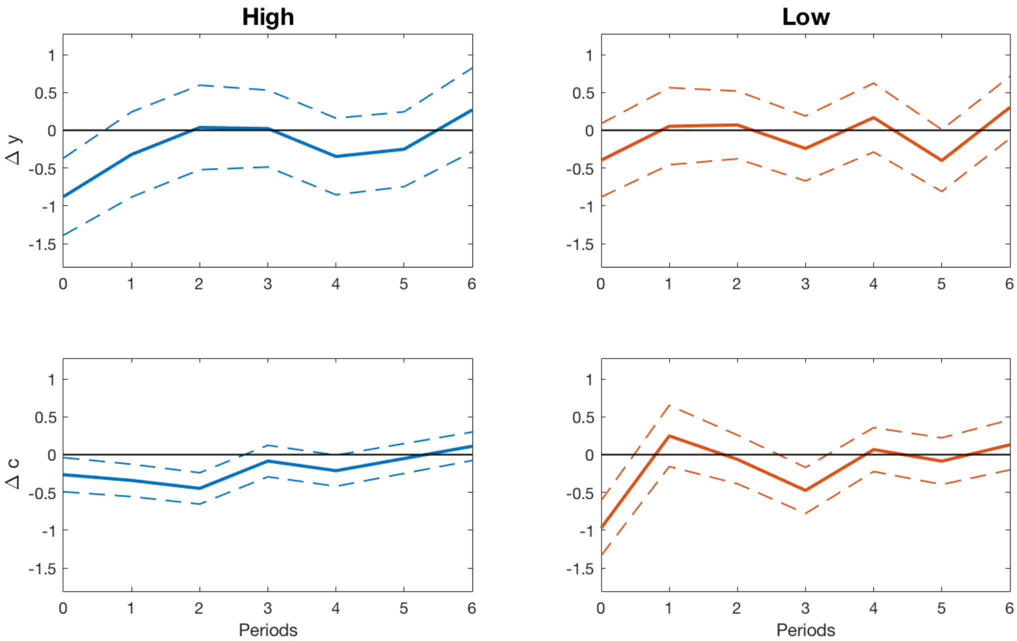

Figure 4: Response of output and consumption growth (per capita) to a global uncertainty shock computed via linear projections. Left (right) panel shows the response in countries with high (low) exposure to global uncertainty.

(2012), we estimate the response of output growth to global uncertainty shocks by means of the projections

$$\begin{aligned} \Delta\, y_{i,t+h} \;&=\; \alpha_y(L)\,\Delta\, y_{i,t} + \alpha_c(L)\,\Delta\, c_{i,t} + \alpha_{xz}(L)\,\Delta\, trade_t \\ &+\; \gamma_h^H\, \mathbb{1}_{\{i\in H\}}\, \varepsilon_t^{global} + \gamma_h^L\, \mathbb{1}_{\{i\in L\}}\, \varepsilon_t^{global} + u_{i,t+h} \end{aligned} \tag{2}$$

where $\mathbb{1}_{\{i\in H\}}$ indicates if country i belongs to the high-exposure group and $trade_t = \frac{X_t - Z_t}{Y_t}$. The responses of consumption and trade are analogous to Eq. 2 with a different variable on the left-hand side. Estimates γ_h^H and γ_h^L are the responses to global uncertainty shocks and their standard errors determine the confidence bounds.

Figure 4 shows the response of output and consumption growth to a global uncertainty shock estimated via linear projections. The shape of the responses corroborates the VAR results, as output falls significantly in highly exposed countries but not in the low exposure group. In addition, the mild and persistent (sharp and short-lived) decline in consumption in the high (low) exposure group are also compatible with the VAR results from the previous

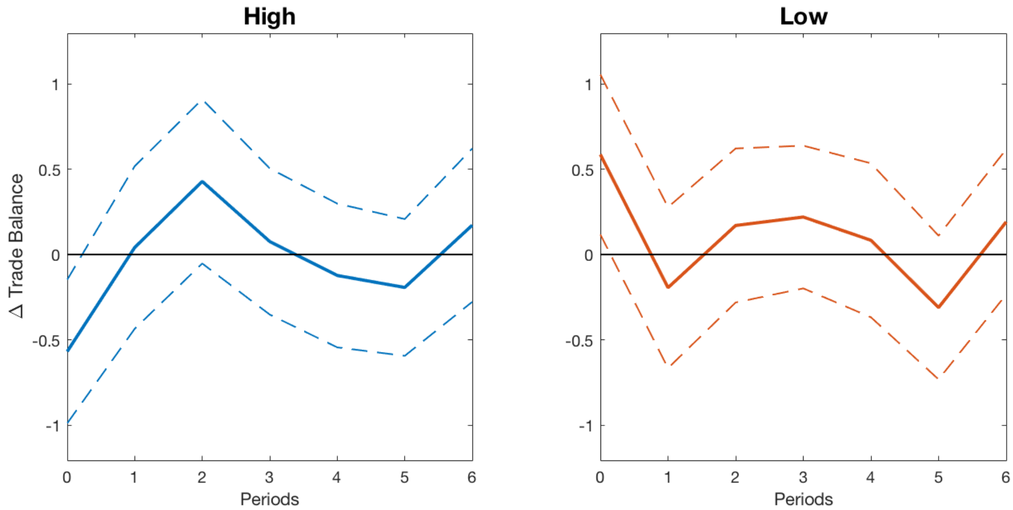

Figure 5: Response of trade balance to a global uncertainty shock computed via linear projections. Left (right) panel shows the response in countries with high (low) exposure to global uncertainty.

section.

The response of the trade balance to a global uncertainty shock also matches the dynamics observed in Figure 3. Highly exposed countries experience a relative increase in imports whereas their low exposure counterparts see a relative increase of exports. In both cases, the trade balance growth returns to steady state one period after the shock hits.

Given the similar response of macro variables to global uncertainty shocks under different approaches, we are confident that observed dynamics are robust to modeling choices and econometric idiosyncrasies.

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