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Global spillover effects of US uncertainty☆

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ABSTRACT

Spillover effects of US uncertainty shocks are studied in a panel VAR of fifteen emerging market economies (EMEs). A US uncertainty shock negatively affects EME stock prices and exchange rates, raises EME country spreads, and decreases capital inflows into them. It decreases EME output and consumer prices while increasing net exports. Negative effects on output and asset prices are weaker, but effects on external balance stronger, for Latin American EMEs. We attribute such heterogeneity to differential EME monetary policy response to US uncertainty shocks. Analysis of central bank minutes shows Latin American EMEs pay less attention to smoothing capital flows.

1. Introduction

What are the international spillover effects of fluctuations in US uncertainty? Given increasing integration of the emerging market economies (EMEs) to the world financial market, how does US financial uncertainty transmit to these countries? Does this cross-border transmission differ among emerging economies, and in particular, do these differences depend on the monetary policy stance of the EMEs?

These issues have received increased attention recently. Policy makers in EMEs often cite increases in US uncertainty as a major reason for revising their economic forecasts downward as well as for an increase in the volatility of international capital flows. US uncertainty fluctuations in fact could have serious policy implications for EMEs beyond simple negative

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spillover effects. Rey (2013) highlights how fluctuations in the Chicago Board of Options Exchange (CBOE) VIX index tend to drive a global financial cycle and thereby, affect global asset prices and financial flows. Rey (2013, 2015) argues that for periphery countries like EMEs, the traditional open-economy policy "trilemma" might have morphed into a "dilemma": Countries cannot have both independent monetary policy and perfect capital mobility, even with flexible exchange rates. The effectiveness of monetary policy of EMEs in mitigating the impact of fluctuations in US uncertainty on macroeconomic and financial variables, however, is barely understood.

This paper contributes to this topic on two main fronts. First, we provide empirically robust estimates of global spillover effects of US uncertainty on both macroeconomic and financial variables in a joint framework of a large set of EMEs. Second, we empirically document a novel pattern of heterogeneity in the spillover effect of US uncertainty across EMEs, and find that differential monetary policy responses by EMEs can rationalize the heterogeneity in cross-border transmission of the US uncertainty shock to these EMEs. Independent supporting evidence that documents heterogeneity in monetary policy concerns among EMEs is also provided from a detailed textual analysis of their central bank policy minutes.

Our empirical framework is a monthly panel VAR for fifteen EMEs: Brazil, Chile, Colombia, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Russia, South Africa, South Korea, Taiwan, Thailand, and Turkey. The panel VAR includes an unanticipated, identified component of US VIX fluctuations as an external shock. For each country, the panel VAR includes a host of macroeconomic and financial variables such as industrial production, consumer prices, the short-term interest rate and the long-term interest spread vis-à-vis the US Treasury yields, exchange rates, stock prices, capital inflows, and net exports. As the resulting panel VAR requires estimating a large number of coefficients, the random coefficient approach is taken to partially pool the cross-sectional information in the data and estimate average effects across EMEs of fluctuations in US uncertainty.

The main empirical results are as follows. Unanticipated changes in US uncertainty are estimated to have significant financial and macroeconomic effects on EMEs. An unanticipated increase in US uncertainty depreciates the local currency of EMEs, leads to a decline in local stock markets, increases long-term interest rate spreads vis-à-vis the US, and is followed by a decrease in capital inflows into EMEs. The effects on EME financial markets are consistently adverse over a two-year horizon. Importantly, it is found that these financial effects transmit to the real economy: in response to a shock to US VIX, on average, output drops, consumer prices decrease persistently, and net exports from these countries to the US rise relative to GDP.

The effects on financial variables suggest that a US uncertainty shock triggers a "flight to safety/quality" phenomenon: Investors appear to pull capital out of the emerging markets that are perceived to be riskier than the US despite the increase in uncertainty in the US, thus negatively affecting asset prices such as stock prices and exchange rates in EMEs, while pushing up their cost of borrowing as country spreads vis-à-vis the US increase. The increase in net exports and decrease in capital inflows implies that one of the channels through which the effects of the US uncertainty shock transmits is via a reduction in aggregate spending of EMEs.

We also assess the heterogeneity in responses between EMEs in Latin America and the rest of EMEs by allowing the effects of the US uncertainty shock to be different across the two subgroups. It is found that Latin American EMEs suffer less in terms of a decrease in output, stock prices, and exchange rates, but experience a more persistent reversal in capital flows and a larger increase in net exports. Specifically, in response to a one standard deviation shock to US VIX, at its peak, output significantly drops by 0.574% in the rest of EMEs while its response is not significant in Latin American EMEs. Moreover, nominal exchange rate depreciates by 0.895% in the rest of EMEs, while it depreciates by 0.353% for Latin American EMEs. In contrast, the effects on external balance measures, such as capital inflows and net exports, are bigger or more persistent for Latin American EMEs compared to the rest of EMEs. The peak negative effect on capital inflows is estimated to be -0.580% relative to GDP in Latin American EME, while it is not significantly different from zero in the rest of EMEs. Similarly, net exports increases by about 0.080% point relative to GDP in Latin American EMEs, but only by 0.019% point relative to GDP in the rest of EMEs.

Intriguingly, compared to Latin American EMEs, the rest of the EMEs get affected more negatively in terms of output, but their short-term interest rates in fact increases. Given a larger output drop than in Latin American EMEs, the short-term interest rates of the rest of EMEs can thus be considered "relatively high" and monetary policy "relatively tight." Our conjecture is that this is to stem capital outflows but such an effect comes at the cost of a larger output contraction and drop in asset prices.[1]

Textual analysis of the EME central bank minutes confirms this hypothesis: it is found that the rest of EMEs are evidently more concerned about capital flow volatility than Latin American countries in our sample. The relative frequency of capital flow-related words in central bank minutes is three times more likely to be above average for the rest of the EMEs compared to Latin America. Indeed, using an index for capital control measures, Latin American EMEs are found to use capital controls to a lesser extent than the rest of EMEs. Thus, the rest of EMEs pay greater attention to capital flows and possibly use both conventional interest rate policy as well as direct capital controls to counteract its volatility.[2]

[1] The consumer price responses show a negative effect on the rest of EMEs as well, which further supports the conjecture that such a policy can be unduly contractionary to the economy.

[2] The online appendix contains a simple two-good small open economy (SOE) model that can account qualitatively for our empirical findings.

Finally, several alternative criteria are considered because of which EMEs could have heterogeneous responses, such as dependence on commodity exports, the burden of US dollar-denominated external debt, and trade (goods and service) integration with the US. EMEs are divided into two subgroups based on these criteria and the panel VAR is re-estimated. The particular pattern of heterogeneity uncovered in our main empirical exercise is not present in these subgroup analysis and thus cannot be explained by the alternative stories.[3]

This paper is related to several strands of the literature. It builds on the body of work pioneered by Bloom (2009) that assesses macroeconomic effects of uncertainty shocks. Miranda-Agrippino and Rey (2015) provide further econometric evidence for the global financial cycle emphasized by Rey (2013). They document the presence of a global factor that explains a significant fraction of variation in global asset returns and show that the US monetary policy shock affects this global factor as well as global credit and financial variables. Our theme is similar in terms of a focus on global spillovers of US financial uncertainty but our empirical work on EMEs is more comprehensive as we capture spillover effects on both macroeconomic and financial variables jointly and study differential effects across EMEs.

Our empirical method is a Bayesian panel VAR with random coefficients, which builds on Canova (2007) and Canova et al. (2013). This approach allows us to make inference on the average effect across EMEs of an external shock on a range of macroeconomic and financial variables, while allowing for heterogeneous country-specific effects. It also allows for the average effect to be different across subgroups of EMEs.

Our comprehensive methodology and scope lead us to identify unique trade-offs in terms of economic and financial stability that EMEs face in the wake of rising US uncertainty. Instead of focusing on a single country estimation at a time or conducting fully pooled estimation, a panel VAR with partial pooling of the sample is used to assess heterogeneity. Moreover, since our framework includes a complete set of open economy variables such as exchange rates, capital flows, and trade flows as well as relative variables such as long-term country spreads, comprehensive evidence is obtained on the cross-border transmission of US uncertainty shocks. For instance, while both the previous literature and our empirical analysis find that US uncertainty has contractionary effects in the US and EMEs, we additionally show that EMEs actually experience a decrease in capital inflows, exchange rate depreciation, and an increase in long-term borrowing costs vis-à-vis the US. Thus, our work empirically establishes the differential effects on EMEs relative to the US and world economy as well as a robust pattern of heterogeneity among EMEs.

Regarding the focus, our work is related to papers that assess empirically the effects of US shocks on EMEs. Our empirical work has a similar theme as Canova (2005), who studies the transmission of US shocks to Latin American countries and Mackowiak (2007), who estimates the effects of US monetary policy shocks on EMEs. In a related work, Bhattarai et al. (2017) study the effects of US unconventional monetary policy shocks on EMEs. Aizenman et al. (2016) show the correlation of EME policy rates and exchange rates, respectively, with policy rates in four center countries. Also closely related are Uribe and Yue (2006), who estimate the effects of foreign interest spread shocks on EMEs using a VAR, and Matsumoto (2011), Akinci (2013), and Carriere-Swallow and Cespedes (2013), who study effects of global financial conditions or VIX shocks on EMEs. Fink and Schuler (2015) study US systemic financial stress shock transmission to EMEs. In this context, our paper is the first to study how the differential response in monetary policy by EMEs might change the transmission of the US uncertainty shock.

Overall, our paper contributes to this growing empirical literature by documenting a novel pattern of heterogeneity among EMEs in their response of macroeconomic and financial variables to an increase in US uncertainty, and ascribing this empirical pattern to differences in monetary policy among the EMEs. Narrative and other evidence support this hypothesis of differential monetary policy response.[4] Our analysis complements that of Farboodi and Kondor (2018). They associate frictions in global financial intermediation with heterogeneous global cycles between advanced and emerging economies but are silent about heterogeneity among EMEs. Our paper documents and explains how differences in the domestic monetary policy response by EMEs can alter the nature of transmission of US uncertainty on their macroeconomic and financial variables.

2. Empirical methodology and data

This section describes the empirical methodology and the data. A US VAR is first estimated to identify unanticipated and exogenous fluctuations in US uncertainty. This shock is then included as an external regressor in a panel VAR for EMEs (EM panel VAR) to assess its spillover effects. Both the US VAR and the EM panel VAR are estimated using the Bayesian approach whose detail can be found in the online appendix. The description of the data is given at the end of the section with further details in the online appendix.

2.1. US uncertainty shock

A VAR model for the US economy is given as

$$y_t = B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_k y_{t-k} + \varepsilon_t, \tag{1}$$

[3] The alternative criterion closest to our baseline is goods trade integration with the US.

[4] We acknowledge that we cannot completely rule out some other fundamental, structural source of heterogeneity across countries that gets reflected in such a differential monetary policy response.

where y_t is an $m_y \times 1$ vector of endogenous variables and $\varepsilon_t \sim \mathbb{N}(0, \Sigma_{US})$ with $E\left(\varepsilon_t | y_{t-j} : j \geq 1\right) = 0$ and Σ_{US} positive definite. The coefficient matrix B_j for $j = 1, \cdots, k$ is an $m_y \times m_y$ matrix. In the baseline specification, y_t includes five variables in the following order: the US industrial production (IP) index as a measure of US output, the US consumer price index (CPI) as the US price level, the OECD IP index as a measure of global output, the global commodity price index, and the CBOE VIX index as a proxy of US uncertainty.[5] The US VAR features global variables as well such that the spillover effect estimates of US uncertainty shocks to EMEs are not confounded by some global factors. The baseline specification uses six lags of y_t ($k = 6$) and is estimated on the monthly data from January 1990 through March 2018.

Given the choice of US and global variables described above, we order VIX in the last place and use the Choleski decomposition to identify a structural shock to VIX, which is referred to as the US uncertainty shock. This recursive identification of the uncertainty shock where VIX is ordered last is also used in Bekaert et al. (2013) and Rey (2013) in a similar setup. It reflects our assumption that output and prices are relatively slow-moving than VIX and they are unlikely to respond to a shock to VIX contemporaneously.[6] Our approach of considering continuous fluctuations in VIX is different from the baseline approach of Bloom (2009), who identify only large jumps in VIX as the uncertainty shock. Continuous fluctuations of the VIX index are adopted as our baseline measure because of concern with the relatively short sample period.[7]

2.2. EM panel VAR

The baseline specification of the EM panel VAR is now presented in detail and alternative specifications to the baseline are discussed.

2.2.1. Baseline specification

After identifying the surprise component in US uncertainty from the US VAR in (1), we assess its spillover effects on EMEs by including it in a system of equations for the economy of EMEs. Suppose that our sample includes N countries indexed by $i = 1, 2, \cdots, N$. The dynamics of endogenous variables for country i are then represented as

$$z_{i,t} = \sum_{j=1}^{p} B_{i,j} z_{i,t-j} + \sum_{j=0}^{q} D_{i,j} \varepsilon_{VIX,t-j} + C_i x_t + u_{i,t}, \tag{2}$$

where $z_{i,t}$ is an $m_z \times 1$ vector of endogenous variables for country i, $\varepsilon_{VIX,t}$ is the median of the US uncertainty shock estimated in the US VAR, x_t is an $m_x \times 1$ vector of exogenous variables including a constant term, dummy variables, and some global variables, and $u_{i,t}$ is an $m_z \times 1$ vector of the disturbance terms.[8] The coefficient matrix $B_{i,j}$ for $j = 1, \cdots, p$ is an $m_z \times m_z$ matrix, $D_{i,j}$ for $j = 0, \cdots, q$ is an $m_z \times 1$ vector, and C_i is an $m_z \times m_x$ matrix. It is assumed that for $\mathbf{u}_t = \left(u'_{1,t}, \cdots, u'_{N,t}\right)'$,

$$\mathbf{u}_t | \mathbf{z}_{t-1}, \cdots, \mathbf{z}_{t-p}, \varepsilon_{VIX,t}, \cdots, \varepsilon_{VIX,t-q}, x_t \sim \mathbb{N}(\mathbf{0}_{Nm_z \times 1}, \mathbf{\Sigma}), \tag{3}$$

where $\mathbf{z}_t = \left(z'_{1,t}, \cdots, z'_{N,t}\right)'$, $\mathbf{0}_{Nm_z \times 1}$ is an $Nm_z \times 1$ vector of zeros, and $\mathbf{\Sigma}$ is an $Nm_z \times Nm_z$ positive definite matrix.

In the baseline specification, $z_{i,t}$ includes five financial variables and three macroeconomic variables: short-term interest rates, long-term interest rate spreads of country i with respect to the 10-year Treasury yield of the US, the aggregate stock price index, the nominal effective exchange rate of the local currency, capital inflows to country i relative to GDP, industrial production as output, CPI as consumer prices, and net exports to the US relative to GDP.[9] These constitute a core set of financial and macroeconomic variables. Note that the short-term interest rate is included to control for monetary policy reactions by these countries.[10] The EM panel VAR is estimated on the monthly sample that covers the period from April 2004 through December 2015. Three lags are included for the endogenous variables and the uncertainty shock ($p = q = 3$).

Since some of EMEs in our sample are commodity exporters, a proxy of the world demand for commodities and a price index of commodities are included in the vector of exogenous variables x_t as control variables. In addition, the world demand

[5] All the variables except VIX are in logs. VIX is included in levels.

[6] Bloom (2009) puts VIX in the second place after the stock price index in the baseline specification but he obtains similar results when ordering VIX in the last place in a robustness exercise.

[7] In our sample period, four major fluctuations in VIX are identified: the financial crisis in 2008–2009 and three European debt crisis events. Following Bloom (2009) would mean that our analysis would be closer to a case/narrative study on spillover effects of financial/debt crisis in advanced economies rather than estimating the effects of general uncertainty fluctuations. In fact, as discussed later, dummy variables for these events are included in the EM panel VAR to address the concern that our results are driven by financial crises outliers. If these four events are not excluded, the effects on the EMEs will be larger in general. Bloom (2009) considers HP-filtered VIX index in a robustness exercise and our method is closer to this approach. Gourio et al. (2013) construct a measure of realized volatility using point-wise averages of several advanced economy volatility measures and then also use that series in a VAR.

[8] Since the median of the US uncertainty shock estimated in the US VAR and its lags are used as regressors in (2), our estimation is subject to the so-called generated regressor problem. As shown in Section 3, however, the US uncertainty shock is very tightly estimated, which suggests that the generated regressor problem is not very severe.

[9] The interest rates are in level and the capital inflows and net exports are a ratio relative to GDP. The other variables are in logs.

[10] As the emerging economies in our sample are heterogeneous in terms of the way they conduct monetary policy, especially in the early sample period, short-term interest rates are used to control for monetary policy rather than either policy rate, money balances, or variables related to the reserve requirement.

is controlled for using the index for overall industrial production of the OECD countries as a proxy. Dummy variables to control for the effect of the global financial crisis (GFC, September-December 2008) and the European debt crisis (May 2010, and February and August 2011) are also included in x_t. EMEs in our sample can be considered as small open economies so these variables in x_t are assumed exogenous to the system as in (3). It is however likely that there are some other common factors that drive their business cycles. No other restriction than being positive definite is imposed on $\mathbf{\Sigma}$ in (3) so that the disturbance terms $u_{i,t}$'s are freely correlated across the countries and capture the potential effects of the other common factors.

Note that the coefficient matrices in (2) are allowed to be different across EMEs. Such dynamic heterogeneity is necessary since EMEs are certainly not homogeneous. However, they are likely to be affected in a similar way by external shocks. To account for potential common effects of the US uncertainty shock, the random coefficient approach is taken with the assumption that the distribution of the coefficient matrices in (2) are centered around a common mean.

Specifically, the random coefficient approach is undertaken following Canova (2007) and Canova et al. (2013). Let us collect the coefficient matrices in (2) as $B_i = \begin{pmatrix} B_{i,1} & \cdots & B_{i,p} \end{pmatrix}'$ and $D_i = \begin{pmatrix} D_{i,0} & \cdots & D_{i,q} \end{pmatrix}'$ and let $\gamma_i = \text{vec}\begin{pmatrix} B_i' & D_i' & C_i \end{pmatrix}'$. Note that the size of γ_i is given as $m_\gamma = m_z m_w$ where $m_w = pm_z + (q+1) + m_x$ is the number of regressors in each equation. It is assumed that for $i = 1, \cdots, N$,

$$\gamma_i = \bar{\gamma} + v_i, \tag{4}$$

where $v_i \sim \mathbb{N}\left(\mathbf{0}_{m_\gamma \times 1}, \Sigma_i \otimes \underline{\Sigma}_i\right)$ with $\mathbf{0}_{m_\gamma \times 1}$ an $m_\gamma \times 1$ vector of zeros, Σ_i an $m_z \times m_z$ matrix that is the i-th block on the diagonal of $\mathbf{\Sigma}$, $\underline{\Sigma}_i$ an $m_w \times m_w$ positive definite matrix, and $E\left(v_i v_j'\right) = \mathbf{0}_{m_\gamma \times m_\gamma}$ for $i \neq j$. The common mean $\bar{\gamma}$ in (4) turns out to be the weighted average of the country-specific coefficients γ_i in the posterior distribution conditional on γ_i's. The average estimates of the dynamics effects of the uncertainty shock $\varepsilon_{VIX,t}$ can be computed by tracing out the responses of $z_{i,t}$ to an increase in $\varepsilon_{VIX,t}$ over time with γ_i replaced by $\bar{\gamma}$.

2.2.2. Heterogeneity across subgroups of countries

The differential effects of the US uncertainty shock across two subgroups of EMEs are also estimated. Suppose that the mean of the coefficients, $\bar{\gamma}$ in (4), is now different between two groups of EMEs, denoted group 1 and 2. So the assumption for the random coefficient approach in (4) is modified as follows: For $i = 1, \cdots, N$,

$$\gamma_i = \bar{\gamma}_1 \times I_1(i) + \bar{\gamma}_2 \times [1 - I_1(i)] + v_i, \tag{5}$$

where $I_1(i)$ is an indicator function that takes on 1 if country i is in group 1 and 0 otherwise, $v_i \sim \mathbb{N}\left(\mathbf{0}_{m_\gamma \times 1}, \Sigma_i \otimes \underline{\Sigma}_i\right)$. By comparing the impulse responses to the US uncertainty shock across these two subgroups, using $\bar{\gamma}_1$ and $\bar{\gamma}_2$, respectively, we study whether these two groups were differentially sensitive to the US uncertainty shock.

Our baseline subgroup estimation consists of Latin American countries in one group and the rest of EMEs in another. This choice is motivated by the close connections between the US and Latin American countries such as the high level of trade linkages and investment between them, the geographical proximity, as well as the existence of previous work that focuses on these countries, such as Canova (2005). In addition, it is often noted that the central banks of many EMEs that belong to the non-Latin American group in our sample worry about volatile international capital flows, for which extra evidence by textual analysis of their monetary policy meeting minutes is presented.

2.2.3. Alternative specifications

After estimating the baseline specification, we consider some alternative specifications to assess robustness of our baseline empirical results. Our first alternative specification considers a different subgrouping of EMEs by including Mexico in the rest of EMEs. This is motivated by the fact that Mexico is plausibly different from the other Latin American countries in our sample because of its close integration with the US, including being part of the free trade agreement NAFTA, as well as its relative lack of commodity dependence in exports. Several other subgroupings of EMEs, based on explicit criteria, are considered to check alternative explanations for the heterogeneity in responses across EMEs. These are discussed in detail later when presenting the results.

Next, our EM panel VAR is estimated exclusively in the post-GFC sample from January 2009 through December 2015. Though dummy variables are included in the baseline specification to control for influences of GFC, another specification considered is an exclusively post-GFC estimation to make sure that results are not driven by the GFC. Because of the considerably shorter sample, however, in this exercise a smaller scale specification is used excluding net exports.

2.3. Data

The data source for most of US data is FRED maintained by the St. Louis Fed. Our EME sample includes fifteen countries: Brazil, Chile, Colombia, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Russian, South Africa, South Korea, Taiwan, Thailand, and Turkey.[11] The sources of the EME data include Datastream, Bloomberg, BIS, IMF, OECD, and the central bank

[11] These countries are selected based on the classification by the IMF and Morgan Stanley. Countries that experienced crises during our sample period, such as Argentina and Venezuela, as well as countries that are likely to actively manage their exchange rates are not included. Countries in the Euro zone are also excluded since they use a common currency and do not have their own monetary policy.

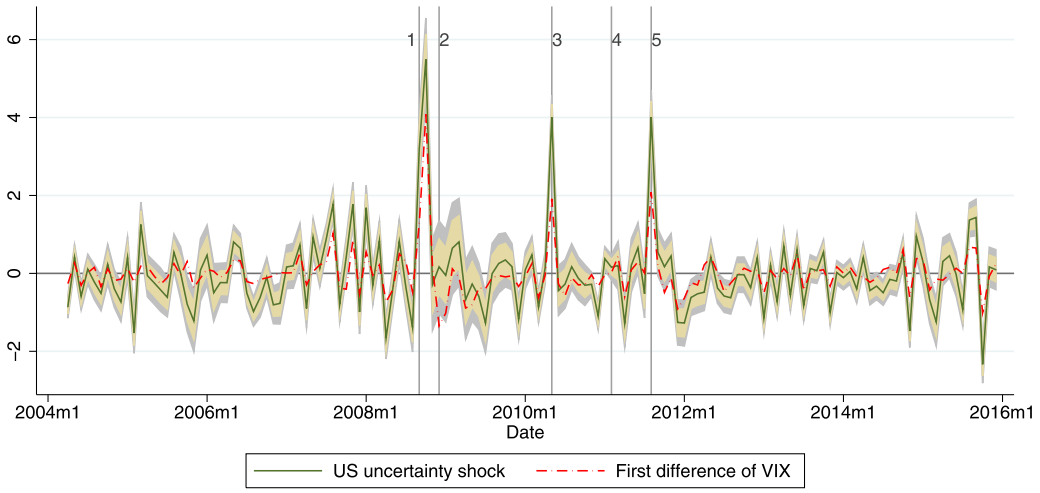

Fig. 1. Estimated US uncertainty shocks and first difference of VIX.
Notes: The US uncertainty shock is the posterior median of the shock to VIX identified in the US VAR in Eq. (1), shown for the sample period of the EM panel VAR (April 2004 through December 2015). It is presented together with 68% and 90% error bands. The first difference of VIX is normalized by the standard deviation of VIX. The vertical lines mark the global financial crisis and the three major events of the Euro debt crisis: [1-2] September 2008 through December 2008 when Lehman Brothers collapsed and subsequently the financial markets were disturbed, [3] May 2010 when the Eurozone members and the IMF agreed on a large bailout package for Greece, [4] February 2011 when the Eurozone bailout fund, the European Stability Mechanism, was set up, and [5] August 2011 when the European Commission President Jose Manuel Barroso warned that the sovereign debt crisis was spreading beyond the periphery.

and the national statistics agency for some countries.[12] In particular, the capital flow data is provided by Bertaut and Judson (2014), which is based on the Treasury International Capital (TIC) system data. The cumulative flow of the foreign asset holdings of the US vis-à-vis EMEs in the dataset is used.

3. Spillover effects of the US uncertainty shock

This section reports the empirical results. It starts with the estimate of the US uncertainty shock and then proceeds to present the spillover effects on the EMEs.

3.1. US uncertainty shock

Fig. 1 presents the posterior median of the estimated US uncertainty shock, along with 68% and 90% error bands. For comparison, the same figure also plots the first difference of VIX, which exhibits similar trends as the estimated uncertainty shock for most periods. As we control for US and global variables and identify US uncertainty shocks from other contemporaneous shocks, there are however instances where the US uncertainty shock fluctuates differently from the first difference of VIX. The US uncertainty shock occasionally takes on large values, especially around those dates marked by vertical lines. These dates are associated with GFC and the Euro Area debt crisis. To ensure that our results are not driven by these episodes, dummy variables for these dates are included in the EM panel VAR.

Fig. A.1 in the online appendix reports the impulse responses of the US VAR which shows that a rise in US uncertainty has a contractionary effect on the US economy and the global economy proxied by the OECD. US consumer prices and the global commodity prices are estimated to decline in response to a US uncertainty shock. This contractionary effect in the US, and even in the global economy, of a US uncertainty shock provides an important context for the spillover effects on EMEs that are shown next. Given a contractionary effect in the US of some shock, one might expect that the US experiences a rise in borrowing costs, an exchange rate depreciation, and capital outflows. It is however found that this is not the case as the exchange rate of EMEs depreciates and they experience a net exports increase and a decrease in capital inflow, while interest rate spreads vis-à-vis the U.S. increase. Thus, in relative terms, one could argue that the US uncertainty shock has even stronger contractionary effects on EMEs than on the US.

[12] The data is not pre-processed before estimation and the variables are used in logs, in levels, or in ratios relative to GDP. The exception is the interpolation of quarterly nominal GDP to the monthly frequency to construct some ratios relative to GDP. The interpolation method is also described in the online appendix.

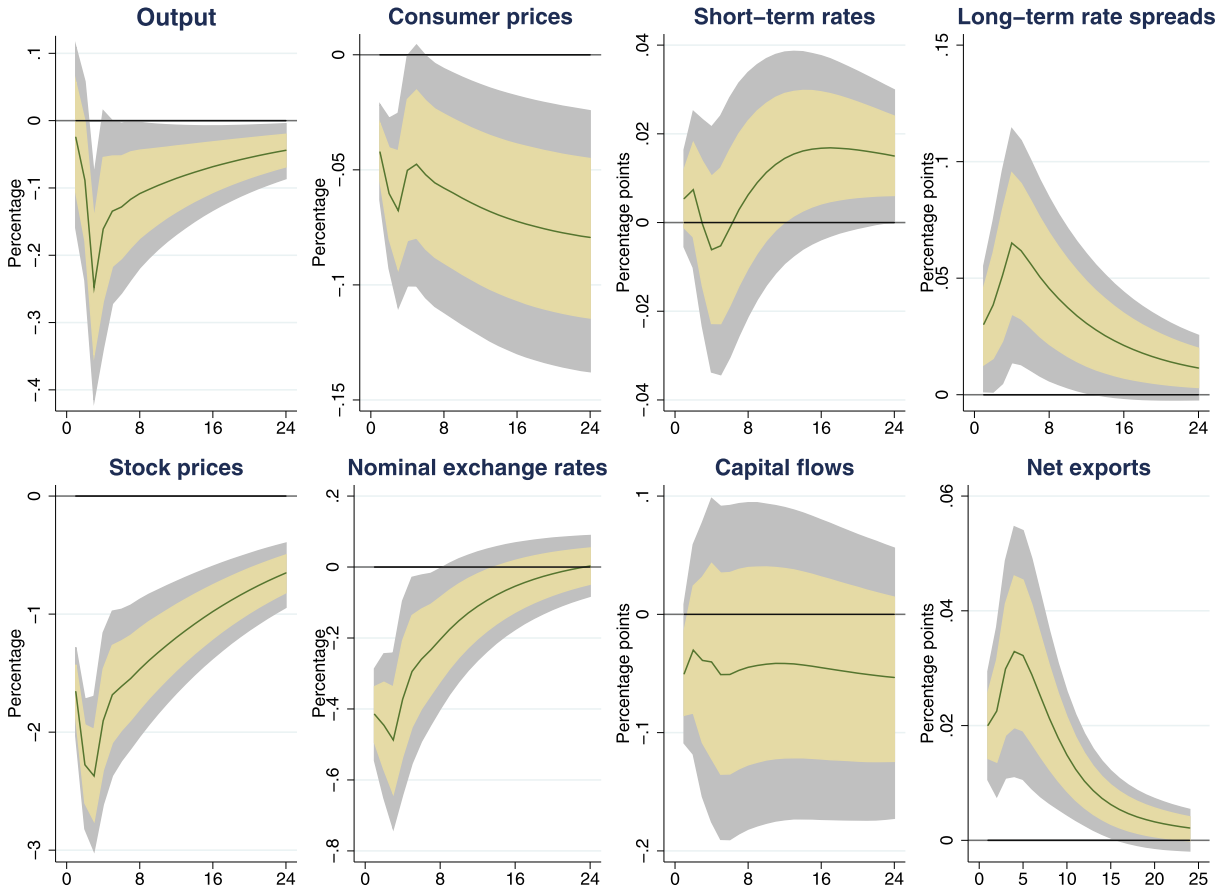

Fig. 2. Impulse responses of the EM panel VAR to the US uncertainty shock: Baseline specification.
Notes: Each plot presents the posterior median of the impulse responses to a one-standard deviation shock to US uncertainty along with the 68% and 90% error band in the baseline specification. Output is the industrial production index and consumer prices are the CPI. The long-term rate spread is the spread between the 10-year Treasury yields in the US and the long-term interest rate in the EM countries. The stock price is the MSCI. The nominal exchange rate is the effective exchange rate of the EM countries so a decrease in the exchange rate implies depreciation of the local currency. The capital flow is the cumulative sum of the flow data of EME assets held by the US residents relative to GDP of EMEs. Net exports are net exports from the EM countries to the US relative to GDP of EMEs.

3.2. Spillover effects

The results on the US uncertainty shock's spillover effects on EMEs are now reported. The impulse responses presented in this section are the average effects of the US uncertainty shock across all the EMEs in the baseline panel VAR specification and the average effects among Latin American EMEs and the rest of the EMEs, respectively, in the subgroup analysis.

3.2.1. Benchmark specification

Fig. 2 reports results from our baseline specification. Let us start with the results on financial market variables as they provide the first channel of possible transmission to EMEs. On average, following an increase in US uncertainty, long-term country spreads (vis-à-vis the 10-year Treasury yield in the US) of these countries increase persistently. In addition, stock prices fall and nominal exchange rates depreciate. Finally, capital inflows to emerging markets decrease.

Specifically, on average across EMEs, a one-standard deviation shock to US VIX leads to a 0.017% point increase in the short-term interest rate, a 0.065% point increase in the long-term interest rate compared to the US, a 2.372% fall in the stock prices, a 0.487% depreciation of the local currency, and a 0.053% point decrease in capital inflows relative to GDP. These are peak effects of US uncertainty fluctuations that occur over two years after the impact. The effects are overall adverse over this horizon. This result suggests that a US uncertainty shock triggers a flight to safety/quality phenomenon as investors appear to pull capital out of these markets that are perceived to be risky compared to the US, which negatively affects asset prices such as stock prices and exchange rates in EMEs. Their cost of borrowing goes up as country spreads increase.

Fig. 2 shows that an increase in US uncertainty also has effects on the macroeconomy of EMEs. Output of these countries drops while net exports increase. Moreover, consumer prices decrease in EMEs. Specifically, in response to a one-standard

deviation shock to US VIX, on average, output drops by 0.248% and net exports from these countries to the US rise by about 0.033% point relative to GDP. These are peak effects, which occur after a delay of 2–4 months. Consumer prices decrease persistently and reach about −0.079% lower toward the end of the two-year horizon. These spillover effects can be large and economically meaningful in events where uncertainty suddenly jumps in the US.[13]

The decrease in output shows that increases in US uncertainty lead to a contractionary effect in EMEs. This is consistent with the concurrent financial market effects such as increases in long-term country spreads and decreases in stock prices. The increase in net exports and decrease in capital inflows jointly illustrates that the effects of the US uncertainty shock transmits through these countries via a reduction in aggregate spending of EMEs. It is well-known that EMEs have in general countercyclical net exports and current account, which is shown here for a particular shock. Finally, consumer prices decrease, which we conjecture is due to a contraction in aggregate output.[14]

3.2.2. Subgroup analysis

For central banks concerned with financial stability, a rise in US uncertainty presents additional challenge. Here, we present results by splitting EMEs into two subgroups: Latin American EMEs (Brazil, Chile, Colombia, Mexico and Peru) and the rest of EMEs (India, Indonesia, Malaysia, the Philippines, Russia, South Africa, South Korea, Taiwan, Thailand, and Turkey). Fig. 3 shows that interesting heterogeneity between the two subgroups is present in responses of both macroeconomic and financial variables. The negative effects on output, stock prices, and nominal exchange rates are bigger and more persistent for the rest of EMEs compared to Latin American EMEs. Specifically, output significantly drops by 0.574% in the rest of EMEs while its response is not significant in Latin American EMEs.[15] Stock prices significantly decline in both groups of countries, but the peak effect is larger and the effects more persistent for the rest of EMEs. Nominal exchange rate depreciates by 0.895% in the rest of EMEs, while it depreciates by 0.353% for Latin American EMEs. The effects on nominal exchange rates are also more persistent for the rest of EMEs.

In contrast, the effects on external balance measures, such as capital inflows and net exports, are bigger or more persistent for Latin American EMEs compared to the rest of EMEs. The peak negative effect on capital inflows of a one standard deviation shock to US VIX is estimated to be −0.580% relative to GDP in Latin American EMEs, while it is not significantly different from zero in the rest of EMEs. The decline in capital inflows occurs very persistently for Latin American EMEs. Net exports increase by about 0.080% point relative to GDP at its peak in Latin American EMEs, but only by 0.019% relative to GDP in the rest of EMEs. Thus, Latin American EMEs suffer less in terms of output, stock prices and the exchange rate, but they respond more strongly in terms of external balances with a larger increase in net exports and a more persistent reversal in capital inflows.

Interestingly, the short term interest rate of the rest of EMEs increases by more compared to their Latin American counterparts, despite them getting affected much more negatively in terms of output. So the increase in the short term interest rate in these countries goes against output stabilization. In this sense, the short term interest rate of the rest of EMEs can be considered to be “relatively high” and monetary policy “relatively more tight” given the larger negative response of output.

To do this inference on subgroup differences formally, Fig. 4 presents the differences in the responses of the rest of EMEs compared to Latin American EMEs. The difference in the response of output, short term interest rates, stock prices, exchange rates and capital inflows is statistically significant with 90% probability, as demonstrated in the Fig. 4. Even for consumer prices and net exports in fact, the difference is statistically significant with 68% probability.[16] Thus, it can be concluded that taking statistical uncertainty into account rigorously, Latin American EMEs compared to the rest of EMEs have a smaller drop in output, exchange rates, and stock prices, but a larger reversal in capital inflows and a bigger increase in net exports. Moreover, this differential effect goes together with a rise in short-term interest rates in the rest of EMEs.

How to interpret and rationalize these subgroup differences in transmission of the US uncertainty shock to EMEs? The increase in the short term rate among the rest of the EMEs, despite being faced with a sharper output contraction, suggests an intriguing explanation based on the differences in monetary policy reactions by the two groups of EMEs that can account for the heterogeneity in spillover effects. It is well-known that many EMEs are worried about sharp reversals in capital flows. For example, the research network of Asian central banks has an expert group on capital flows to promote information sharing on capital flows among members and to work on proposals to enhance the management of capital flows.[17] In a

[13] For perspective, the effect on output for EMEs of US uncertainty shock is smaller, but of a similar order of magnitude, as the effect on output for the US. In particular, as shown in Fig. A.1 in the online appendix, a one standard deviation shock to US VIX leads to a output drop of around 0.2% after 4 months and 0.4% after 24 months.

[14] Our baseline empirical results remain robust if TIC data is replaced with EPFR capital flows data, as demonstrated in Fig. A.5 in the online appendix. The EPFR data covers portfolio investment in equities and bonds by global mutual funds, exchange-traded funds, and some other funds. The EPFR data covers capital inflows from other countries as well as the US but it does not cover all the portfolio flows in BOP data. It is thus used as an alternative capital flow measure as a robustness check.

[15] Only at 68% probability level, the output response is weakly positively significant after 12 periods or so, for Latin American EMEs.

[16] Finally, note that long-term rate spread difference is not significant, which shows that the effect of the uncertainty shock through simply differential effects on long-term spreads cannot explain our results per se.

[17] The South East Asian Central Banks (SEACEN) Research and Training Center (https://www.seacen.org). Its membership covers central banks of some Asian and Pacific countries as well as in South East Asia. Among the rest of EMEs of our sample, the central banks of all seven Asian countries (India, Indonesia, Malaysia, the Philippines, South Korea, Taiwan, and Thailand) are a member of the SEACEN Center. The Center also publishes a bi-annual report on cross-border capital flows of SEACEN member economies.

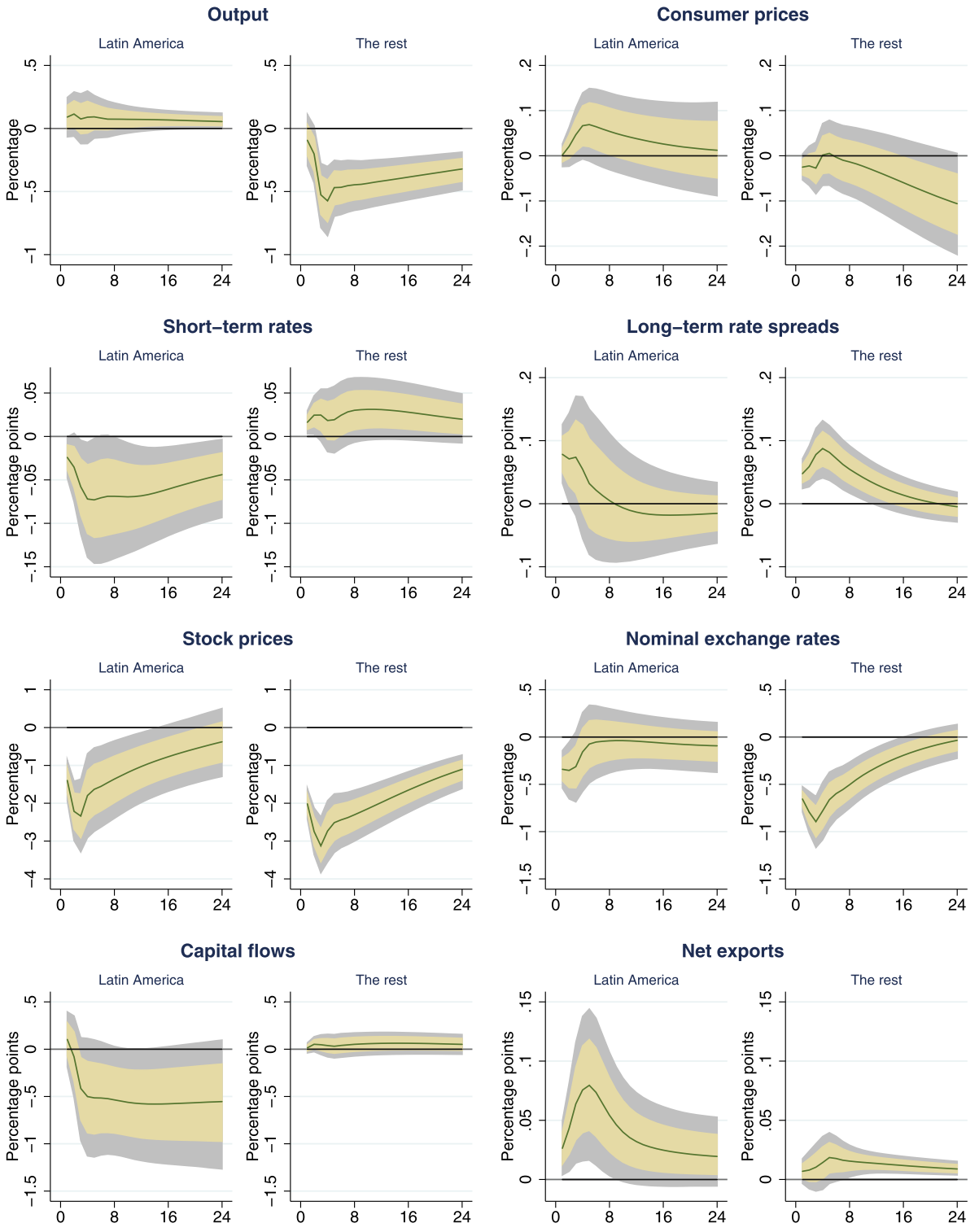

Fig. 3. Impulse responses of the EM panel VAR to the US uncertainty shock: Latin America vs. the rest.
Notes: Each plot presents the posterior median of the impulse responses to a one-standard deviation shock to US uncertainty along with the 68% and 90% error bands. Subplots are shown for two groups of countries: Latin America including Brazil, Chile, Colombia, Mexico, and Peru and the rest of the EMEs (India, Indonesia, Malaysia, the Philippines, South Africa, Russia, South Korea, Taiwan, Thailand, Turkey). See the notes in Fig. 2.

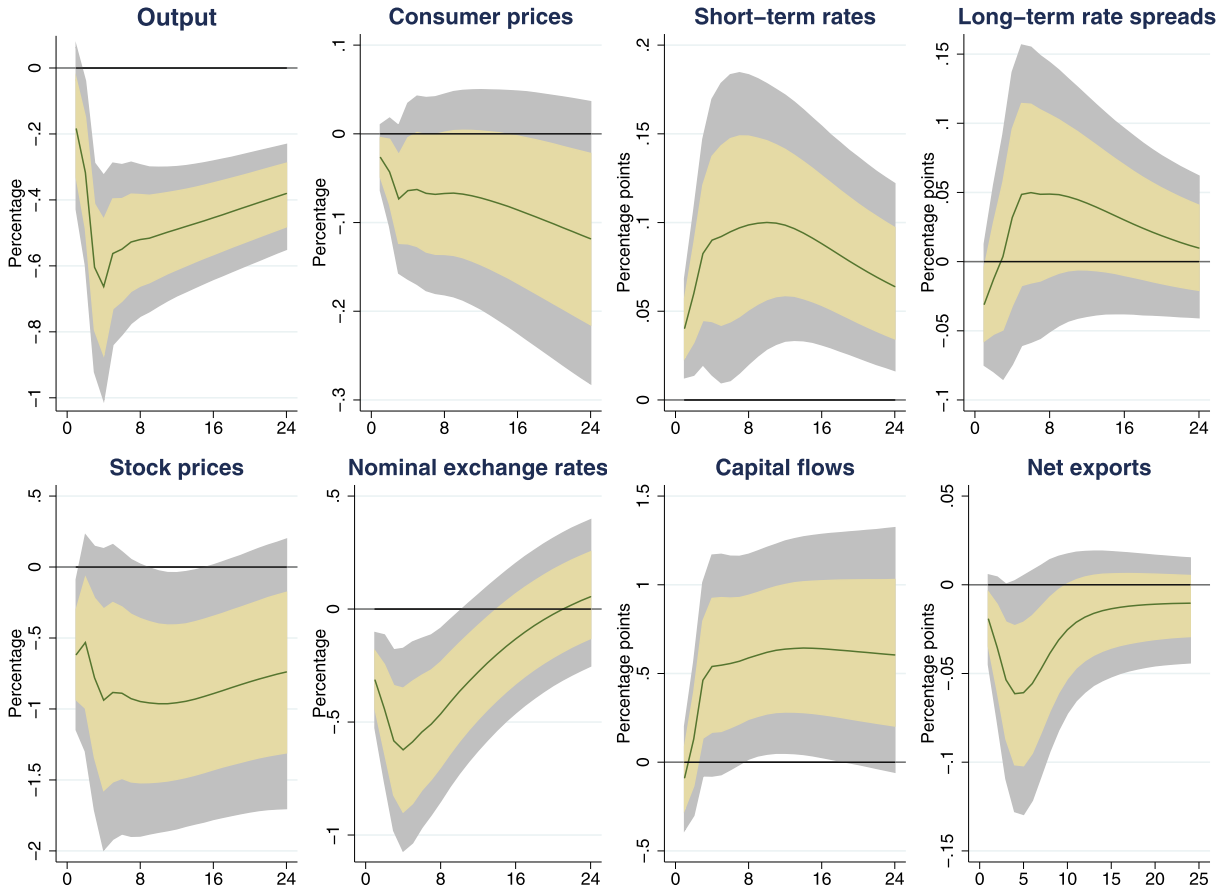

Fig. 4. Differential responses of the EM panel VAR to the US uncertainty shock: the rest minus Latin America.
Notes: Each plot presents the posterior median of the differences of the impulse responses to a one-standard deviation shock to US uncertainty between the rest of EMEs and Latin American EMEs along with the 68% and 90% error bands. The differences are computed using the posterior draws of $\bar{\gamma}_2$ for the rest of EMEs and $\bar{\gamma}_1$ for Latin American EMEs in Equation (5), which show the impulse responses of the rest of EMEs *minus* the impulse responses of Latin American EMEs. See the notes in Fig. 2.

speech titled "Challenges to South African Monetary Policy in a World of Volatile Capital Flows," the Governor of South African Reserve Bank also mentions:[18]

> The continued uncertainties in the global economy ... have contributed to periodic bouts of risk aversion, often resulting in a flight to so-called safe havens, despite the fact that the underlying fundamentals in the emerging markets have not changed. The problem ... is one of ... excessively volatile portfolio flows, which respond to the vagaries of global risk aversion. (Address to the Swiss Chamber Southern Africa, May 2012)

If the rest of EMEs are more concerned with capital outflows than Latin American EMEs, the central banks of these countries may want to keep their policy rates relatively high in order to offer higher returns to foreign investors and stem such capital outflows, which will lead to relatively high short term interest rates. This can be successful but might come at the cost of larger drops in output as monetary policy will turn out to be unduly contractionary.[19] Motivated by this, we undertake a formal analysis of EME central bank policy minutes in Section 4.1 to provide rigorous evidence in support of our hypothesis.

3.2.3. Extensions and robustness exercises

The results from including Mexico in the rest of EME group are presented in Fig. 5. Recall that our main motivation for this exercise is that Mexico has deep interconnections with the US and also does not share some aspects with the other

[18] Note that South Africa belongs to the rest of EMEs. The paper later contains more systematic narrative evidence as well as other relevant examples.
[19] This kind of trade-off guides the theoretical model in the online appendix that introduces heterogeneity in monetary policy rules. Moreover, as mentioned before, consumer prices also drop in the rest of EMEs, further supporting our conjecture that monetary policy response is unduly contractionary.

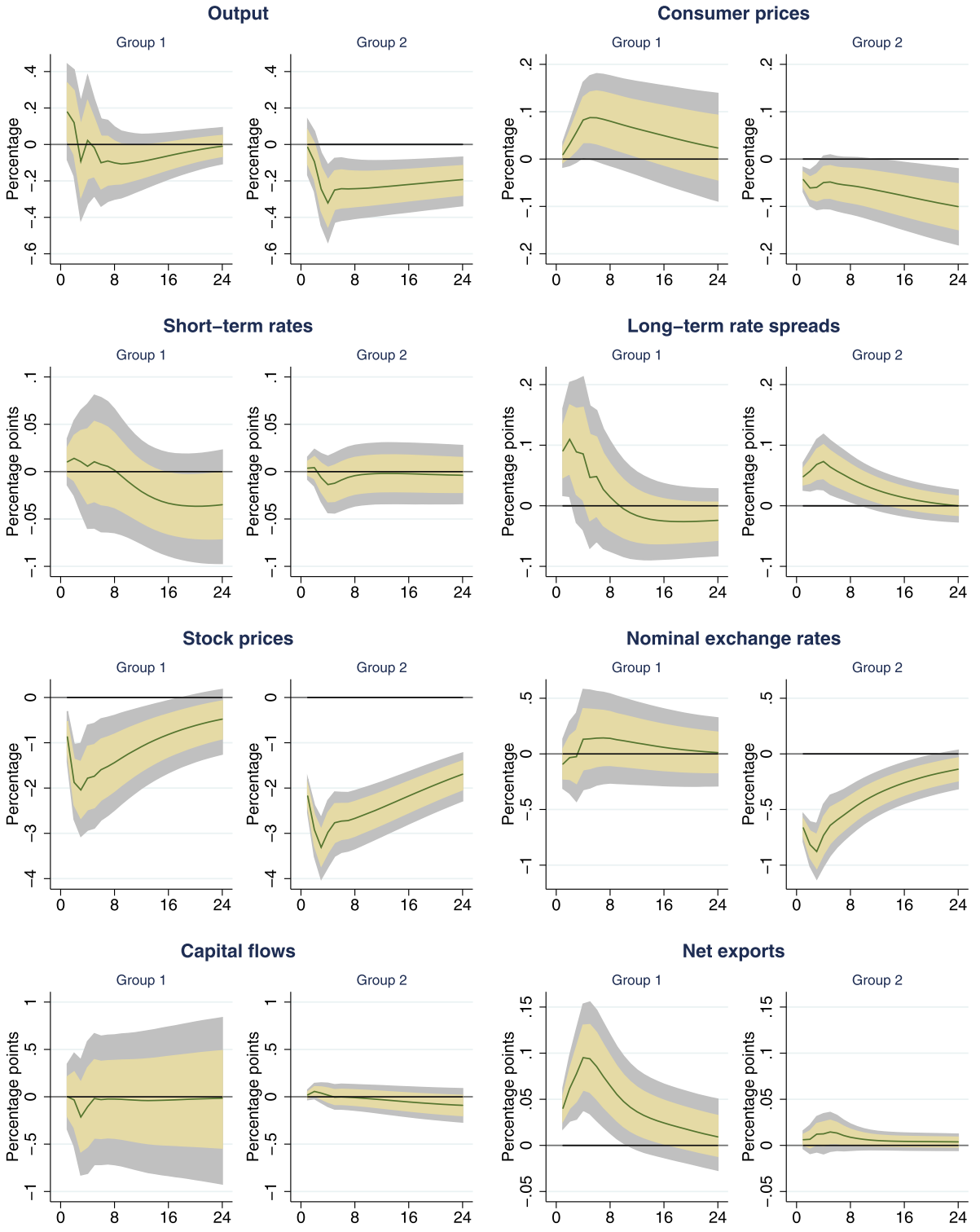

Fig. 5. Impulse responses of the EM panel VAR to the US uncertainty shock: Latin America except Mexico (Group 1) vs. the rest (Group 2).
Notes: Each plot presents the posterior median of the impulse responses to a one-standard deviation US uncertainty shock along with the 68% and 90% error bands. Subplots are shown for two groups of countries: Group 1 includes Latin American EMEs (Brazil, Chile, Colombia, Peru) and Group 2 contains the rest of EMEs (India, Indonesia, Malaysia, the Philippines, South Africa, Russia, South Korea, Taiwan, Thailand, Turkey) and Mexico. See the notes in Fig. 2.

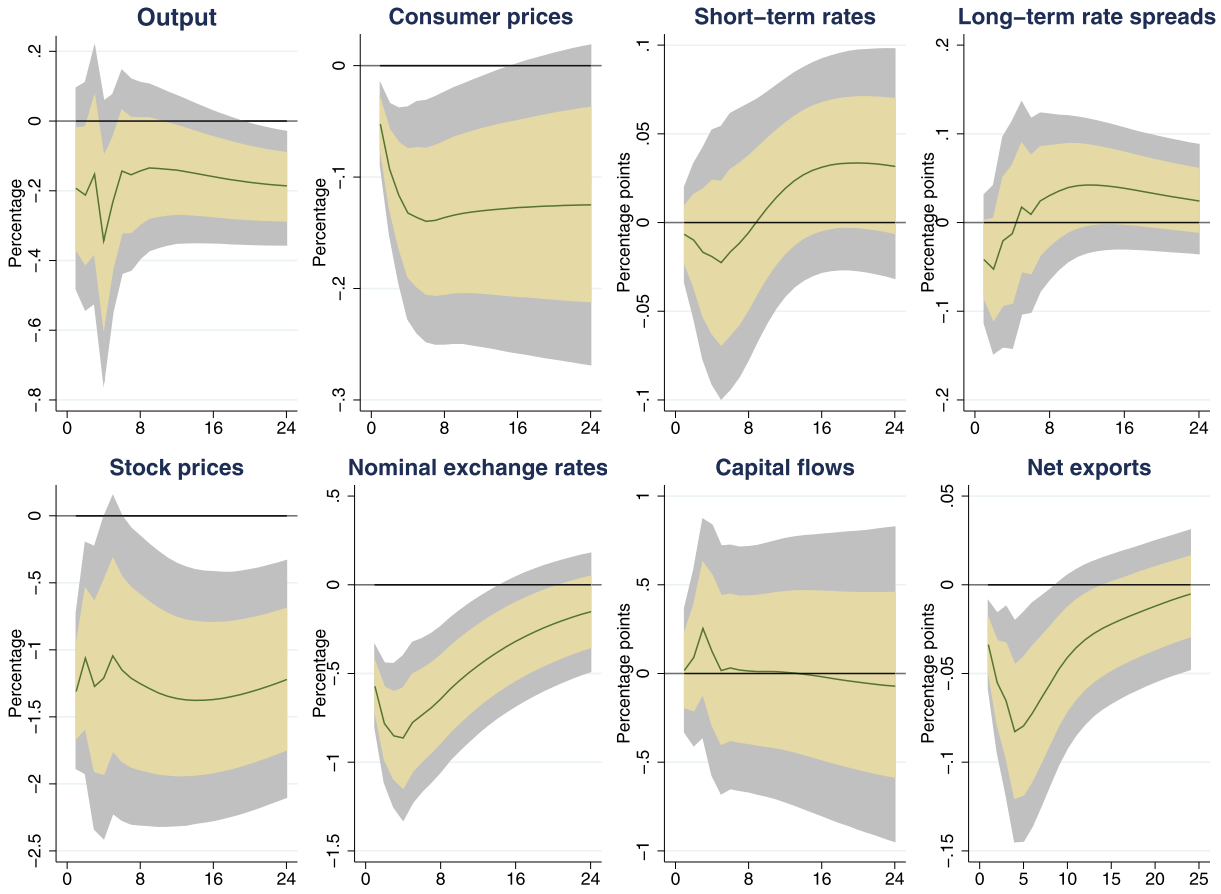

Fig. 6. Differential responses of the EM panel VAR to the US uncertainty shock: the rest (Group 2) minus Latin America except Mexico (Group 1).
Notes: Each plot presents the posterior median of the differences of the impulse responses to a one-standard deviation shock to US uncertainty between the rest of EMEs including Mexcio and Latin America except Mexico along with the 68% and 90% error bands. See the notes in Fig. 4.

Latin American EMEs, such as high commodity dependence in exports. If Mexico is closer to the rest of EME groups for these reasons, the subgroup analysis where Mexico is moved to the rest of EMEs will strengthen the heterogeneity in responses between the two groups. Fig. 5 shows that, compared to our baseline results in Fig. 3, while the heterogeneity is qualitatively similar, it is quantitatively weaker. For example, output drop in the rest of EMEs, which includes Mexico, is now relatively smaller. Moreover, in Fig. 6, we present the differences in the responses of the rest of EMEs compared to Latin American EMEs except Mexico. Comparing Fig. 6 with our baseline results in Fig. 4, it is clear that the differences between the two groups are weaker for output, capital flows, and short-term interest rates.[20] This exercise provides some support for our baseline grouping of countries, where Mexico is included with other Latin American EMEs.

The results from the sample that starts in 2009 such that it avoids the peak of GFC are presented in Figs. A.2–A.4 in the online appendix. In this post GFC period, the US uncertainty shock is again found to have adverse asset prices and long-term interest rate spread effects on EMEs. Capital inflows also decline. Moreover, in terms of heterogeneity, as in our baseline results, the decline in stock prices and exchange rate is larger, while the decline in capital inflows smaller, for the rest of EMEs compared to Latin American EMEs. The effects on output are noisier and less stark, most likely due to the small sample problem, but probably also related to our finding here that the short-term interest rate declines in this sub-period. Overall, these results show that our findings are not driven by the GFC period alone.

[20] A similar pattern is observed if Mexico is dropped from the sample altogether and the sub-groups are South American EMEs vs the rest of EMEs (excluding Mexico). This result is presented in Fig. A.8 in the online appendix. It shows that compared to the baseline, the results are qualitatively similar but quantitatively weaker. Our inference from these two exercises is that while Mexico might be different from the EMEs in our sample in terms of particularly strong connections with the US, it is more similar to the South American countries, compared to the rest of EMEs.

4. Discussion and external evidence

So far the empirical results of the baseline specification and several robustness exercises have been reported. We now present some evidence, external to the baseline empirical approach, to provide additional validity to our results and interpretation.[21]

4.1. Analysis of EME central bank minutes

Narrative evidence from monetary policy committee meeting minutes of EME central banks overall reveals a picture of the fear of capital flows, particularly evident among the non-Latin American countries in our sample. Moreover, in some instances, considerations for financial stability and fear of capital flows led to changes in monetary policy, despite domestic output and inflation stabilization objectives demanding a different course of policy action.

Perhaps the most prominent example of this "fear of capital flows" is the Central Bank of Republic of Turkey (CBRT) law that explicitly includes financial stability together with inflation targeting in their monetary policy framework. In November 2016, after the US Presidential election-related hike in uncertainty, despite a decline in aggregate economic activity and a fall in inflation, CBRT undertook substantial monetary tightening to take precautions for the enhancement of the stability in the financial system and to mitigate capital outflows:

> In sum, the slowdown in aggregate demand contributes to the fall in inflation. However, the recent exchange rate movements resulting from increased global uncertainty and high volatility limit the improvement in inflation outlook.... *The increased global uncertainty driven by the US presidential election send emerging financial markets into turbulence, inducing portfolio outflows... The Committee decided to implement monetary tightening* (Monetary Policy Committee, CBRT, No. 2016).[22]

This "fear of capital flows" however, is not a homogeneous concern among EMEs. For example, facing similar external considerations in the same month (November 2016), the Board of the Central Reserve Bank of Peru (CRBP) approved to maintain the monetary policy interest rate in their meeting:

> This decision is consistent with an inflation forecast in which inflation is gradually converging to 2.0% in the monetary policy horizon and takes into account that: i) 12 month inflation expectations are within the target range; ii) The effects of the rise in the prices of some food products and fuels on the rate of inflation in September and October have been transitory, so inflation is expected to converge soon to the inflation target range; iii) Local economic activity has been growing at a rate close to its potential growth level, and iv) *The global economy continues showing mixed signals of recovery in production and employment, as well as increased uncertainty in international financial markets. In this scenario, the Peruvian economy maintains sound fundamentals* (Monetary Policy Notes, CRBP, No. 2016).

Thus, there indeed is heterogeneity across EME central banks in terms of the degree of attention and importance they assign to the volatility of capital flows and how they tailor monetary policy in response to these concerns.

In light of these examples that show stark differences in policy focus between EMEs, we take a further step towards a more rigorous analysis by analyzing the entire text of monetary policy meeting minutes of Brazil, Chile, Peru, South Africa,

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[21] A model based interpretation of our results is in the online appendix. In the model, a negative external shock that increases the interest rate spread faced by the SOE produces responses of macroeconomic and financial variables that are consistent with our estimated responses. The model also provides a rationalization for the heterogeneity in responses across countries. Monetary policy is modeled as a Taylor-type rule where the central bank possibly responds to the country interest rate spread in addition to the usual endogenous reaction to inflation and output. This reflects a desire on the part of policy to stem capital outflows. It is shown that in case of such a response by central banks, capital flows are less volatile after the shock, but the response of output and asset prices is stronger.

[22] Similar concerns seem quite pervasive among some EMEs in other contexts. For example, the Reserve Bank of India (RBI) decided to maintain their policy rate constant despite decline in output and inflation after the international monetary policy uncertainty and related capital outflows in May, 2013 due to Taper tantrum:

> On monetary policy measures, four of the seven Members recommended maintenance of status quo in the policy repo rate. In their view, though growth and inflation are projected to move down, we still have to guard against high inflation expectations that can destabilize the momentum of the economy. *Moreover, the external front is fragile and warrants that we do not do anything that can send wrong signals about our discounting the possibility of capital outflows* (Minutes of Monetary Policy Technical Advisory Committee Meetings, RBI, July 2013).

In a similar instance, the Reserve Bank of South Africa (RBS) raised its policy rate despite economic slowdown out of concerns for external financial market uncertainty:

> Since the previous meeting of the Monetary Policy Committee the global environment has been dominated by heightened uncertainty relating to the debt crisis in Greece and the sharp decline in equity prices in China. While the tail risks from these events appear to have dissipated somewhat, uncertainties still remain. *At the same time, the risks associated with financial market volatility related to the timing of the first increase in the US policy rate persist. Domestically, the growth outlook remains weak, as both the supply and demand sides remain constrained amid declining business and consumer confidence. The MPC has therefore decided ... the repurchase rate will increase by 25 basis points to 6 per cent per annum with effect from Friday 24 July 2015* (Monetary Policy Committee, RBS, July 2015).

Note that India and South Africa belong to the rest of EMEs in our sample.

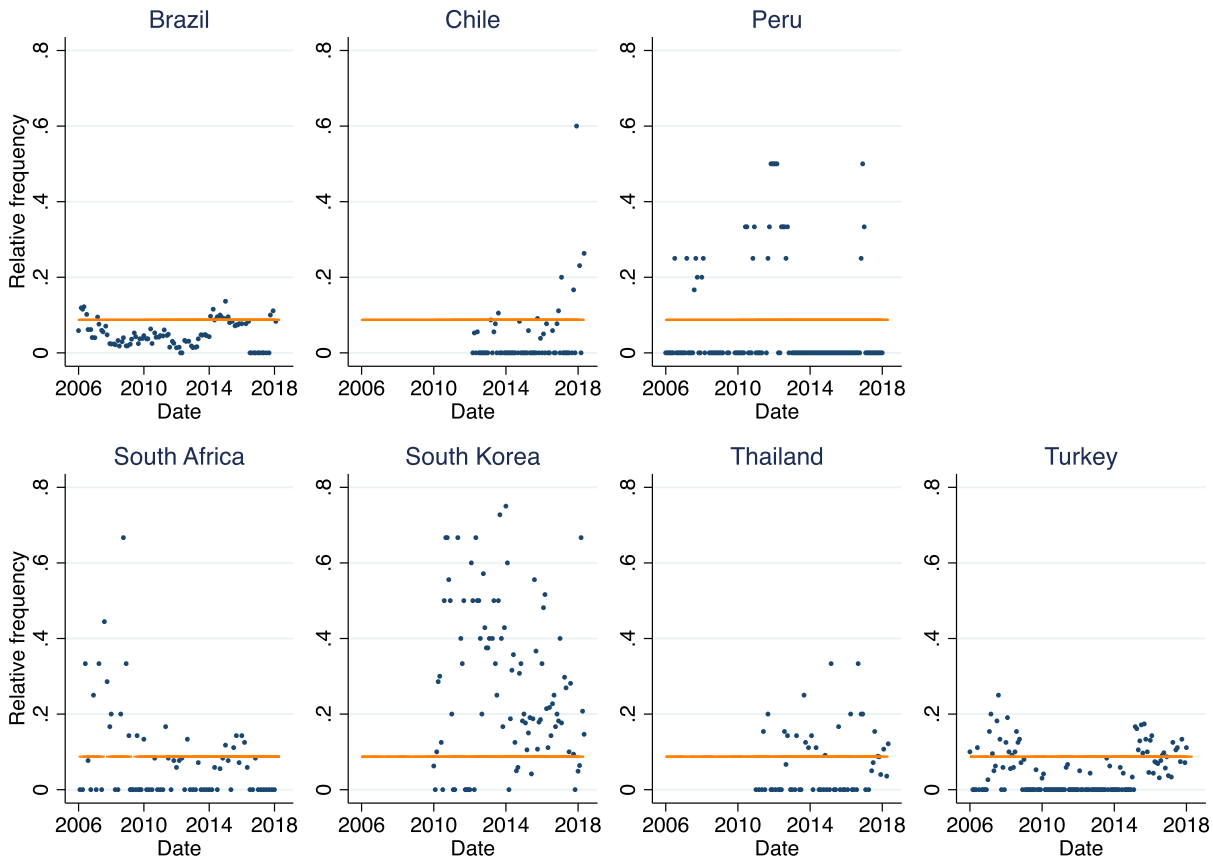

Fig. 7. Differential responses of the EM panel VAR to the US uncertainty shock: Countries with low commodity dependence in exports (Group 2) minus Countries with high dependence (Group 1).
Notes: Each plot presents the posterior median of the differences of the impulse responses to a one-standard deviation shock to US uncertainty between the countries with low commodity dependence in exports (Group 2: India, Malaysia, Mexico, the Philippines, South Korea, Taiwan, Thailand, Turkey) and the countries with high commodity dependence in exports (Group 1: Brazil, Chile, Colombia, Indonesia, Peru, Russia, and South Africa), along with the 68% and 90% error bands. See the notes in Fig. 4.

South Korea, Thailand, and Turkey from 2006 to 2018.[23] In particular, the capital flow concern is measured as the number of times monetary policy minutes contain words in the group {"international capital market", "international market", "global financial condition", "international financial market", "global market", "global economic conditions", "global economic environment", "foreign investment", "international financial environment", "global financial environment", "portfolio", "foreign capital"} and contrast this to the output stabilization concern measured as word count in the group {"output", "economic activity", "employment", "economic growth", "production", "domestic demand", "domestic activity", "labor market", "labour market"}.[24] Because all of these central banks are currently official inflation targeting central banks, naturally they are concerned with price stabilization. Hence, output stabilization is used as the appropriate scale to compare with for capital flow concerns.

Fig. 7 plots the relative frequency of capital flow words (compared to output stabilization words) in central bank minutes for the seven countries, split between Latin America and the rest of EMEs. As the figure confirms, a pervasive fear of capital

[23] Our sample is limited by the availability of central bank policy meeting minutes. Very few emerging countries have minutes of monetary policy committee meetings publicly available at a regular frequency over our entire sample period. For example, India has very infrequent minutes in the earlier part of the sample and more frequently only in the last few years and Mexico has only the official Spanish version of the minutes over our sample period. Hence, the sample is restricted to seven major countries that regularly release minutes over this time period. For some of these countries minutes are only available in later years. For more information, see the online appendix.

[24] A brief description of our method is as follows. The minutes are saved as plain text files, and read as strings. The count function from the String library of Python is used to return the number of instances of each keyword within the entire text and then sum it up to get the total score for each set. The scores have been normalized by dividing by the total word count for the entire MPC text. Regarding the count function, each occurrence of the keyword passed to count is counted, even when the keyword is contained within another set of strings. For example, if the string being searched for is S, and the string xSy is present within the text, it will be counted. Thus, if the keyword being looked for is "flow" and "outflow" is present in the text, that would be counted as an occurrence. This leads to the possibility of double-counting if within a list, one keyword is a proper substring of another keyword, since it would be counted twice. So, to avoid this, it is made sure that none of the phrases in the list are proper substrings of any other phrase.

flows for South Africa, South Korea, Thailand, and Turkey can be traced, which forms a striking contrast with Brazil, Chile, and Peru. On average, the relative frequency of capital flow words is 8.8% in our sample. But for South Africa, South Korea, Thailand, and Turkey, 41.4% of the times, the relative frequency of capital flow words is higher than this common mean across all the countries. For Brazil, Chile, and Peru, the relative frequency is above this common mean only 16.4% of the times.[25]

Thus, the rest of EMEs, on average, are about three times more likely to express greater concern about capital flows compared to the Latin American countries.[26]

4.2. Capital flow controls

The heterogeneity in responses across subgroups was interpreted based on heterogeneity in monetary policy reactions to capital flows. If these capital flow concerns are more paramount for the rest of EMEs compared to Latin American EMEs, then arguably it should be reflected in other, non-monetary policy choices as well. In particular, the rest of EMEs would be expected to use direct capital flow restrictions measures more extensively.

Results using capital control indices from Fernandez et al. (2015) and Chinn and Ito (2006) are presented next. Fernandez et al. (2015) and Chinn and Ito (2006) construct these indices based on the de jure information extracted from IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The construction of the indices involves using the narrative description in the AREAER to determine whether or not there are restrictions in international asset transactions (with 1 representing restriction and 0 not for instance in the Fernandez et al. (2015) measure). The indices are made available through the NBER.

The results based on these indices are reported in Table A.2 in the online appendix. It shows that Latin American EMEs have higher capital mobility (or less restrictive capital control policies) compared to the rest of EMEs (for instance, 0.38 in Latin American EMEs compared to 0.64 in rest of EMEs using the Fernandez et al. (2015) measure, with a higher number denoting more capital flow restrictions) in our sample. This aligns with our interpretation that the rest of EMEs are using more aggressively both conventional monetary policy instrument as well as direct capital controls to smooth the path of capital flows when external shocks hit these EMEs.[27]

4.3. Possible alternative explanations

The analysis above provides corroborative evidence in favor of differential extents of capital flow concerns among emerging economies that get reflected in differential monetary policy response to a US uncertainty shock. But these countries are heterogeneous in more than one dimension and this raises an important question: is there any other relevant aspect of heterogeneity that may explain the differences in spillover effects? This section explores such possible alternative explanations.

Our approach to assessing such alternative explanations is to group countries based on important sources of heterogeneity such as commodity dependence and US dollar denominated debt, and then estimating the corresponding subgroup EM panel VAR. It is then investigated whether the heterogeneity in responses to the US uncertainty shock highlighted in the paper in terms of Latin American EMEs vs. the rest of EMEs (differential response in output and asset prices vs. external balance) also appears in these alternative subgroups based on observable and important sources of heterogeneity.

First, the countries in our sample vary in terms of their dependence on commodity exports. Some of the countries in our sample are major commodity exporters and because of various factors specific to the commodity market such as commodity super cycle, impact of rise of China on commodity exporters, or tight co-movements between commodity prices and exchange rates (Chen et al., 2010), these countries may experience different spillover effects of an US uncertainty shock. To explore whether our observed pattern of heterogeneity is explained by differential commodity dependence among the emerging economies, we rank the countries by the ratio of total commodity exports to trade or total exports over 2006–2014.[28]

Based on this criteria, a possible alternative grouping is to include the major commodity exporters such as Brazil, Chile, Russia, Peru, Indonesia, Colombia and South Africa in one group and the rest in another. The group specific average commodity dependence measures that support such a sorting is presented in Table A.3 in the online appendix. Based on this alternative grouping, the EM panel VAR is re-estimated. The results are presented in Fig. 8 which shows the differences in the responses of the low commodity dependence group compared to the high commodity dependence group. As is clear, the output and short-term interest rate difference is not significant between the two groups, in contrast with our baseline subgroup differences shown in Fig. 4.

Second, the countries in our sample also differ in the currency composition of their external debt. Financial Exchange Rates and International Currency Exposures data from Lane and Shambaugh (2010) is used to measure exposure to foreign

[25] The online appendix, in Table A.1, reports country-specific statistics.

[26] Consistent with this, the group average of the relative frequency of capital flow words for the rest of EMEs is 11.6%, more than double the group average of 5.3% for the Latin American sample.

[27] Implicitly, our view is that just one of these policy instruments does not suffice to attain the goal of smoothing capital flows, as the environment is one of second-best. The government therefore, uses both instruments, short term interest rate and capital controls, to better attain its objective.

[28] Commodity exports data is obtained from UN COMTRADE following Chatterjee and Saraf (2017).

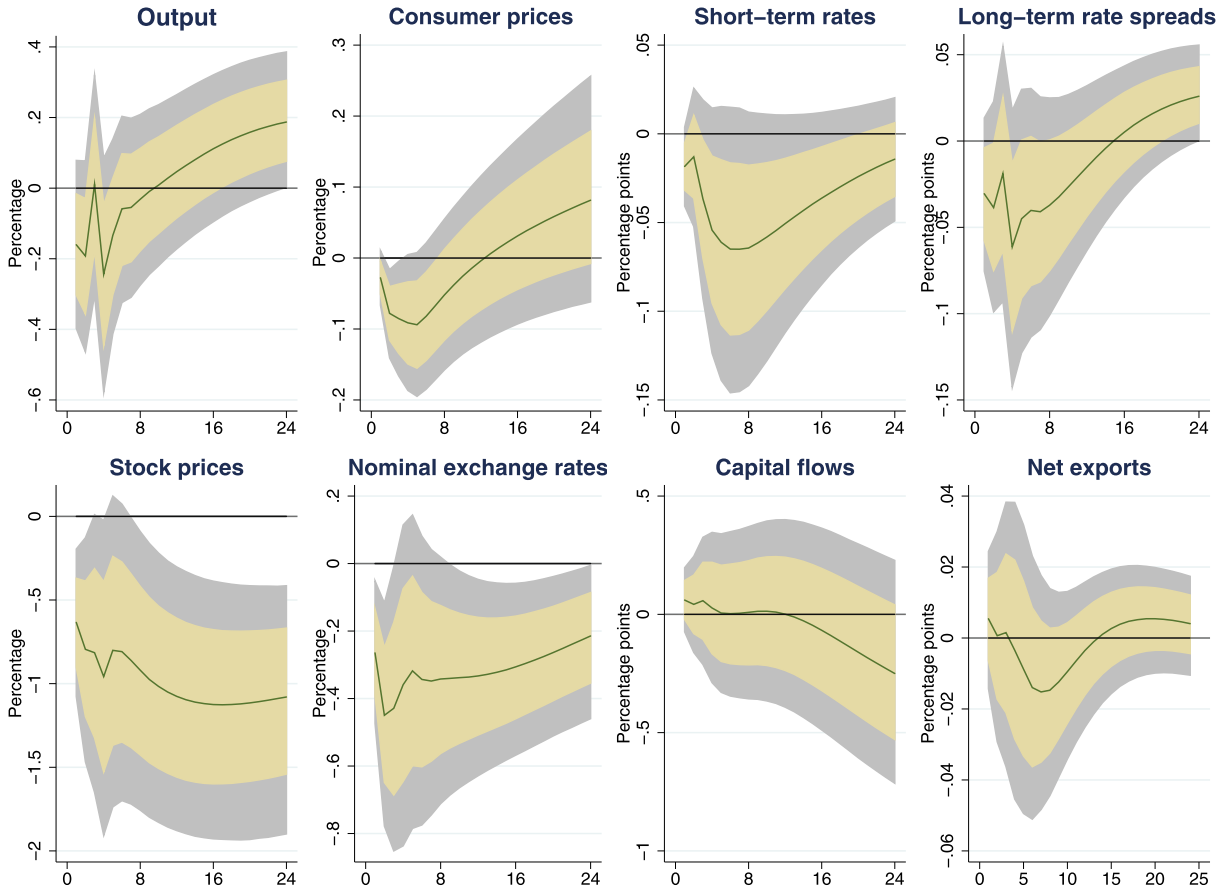

Fig. 8. Differential responses of the EM panel VAR to the US uncertainty shock: Countries with low financial integration to the US (Group 2) minus Countries with high financial integration to the US (Group 1).
Notes: Each plot presents the posterior median of the differences of the impulse responses to a one-standard deviation shock to US uncertainty between the countries with low financial integration to the US (Group 2: Indonesia, Malaysia, the Philippines, South Korea, Taiwan, Thailand) and the countries with high financial integration to the US (Group 1: Brazil, Chile, Colombia, India, Mexico, Peru, Russia, South Africa, Turkey), along with the 68% and 90% error bands. See the notes in Fig. 4.

currency debt. The share of external debt in foreign currency and share of external debt in US dollar is used. While all countries in our sample mostly borrow in foreign currency, there is difference among these countries in terms of their dependence on US dollar denominated debt.[29]

Based on the fraction of US dollar denominated debt, Turkey, India, South Africa, and Russia are grouped along with the Latin American EMEs as a group of countries that are potentially more exposed to US financial uncertainty because of their tighter financial integration with the US. Table A.4 in the online appendix reports currency composition of external debt, where we report an average from 2000 to 2004, that supports such a sorting. Fig. 9 presents differences in the responses of the group with lower US dollar denominated debt compared to the group with higher US dollar denominated debt. There is no significant difference in output between the two subgroups of countries. Moreover, the differences in stock prices and nominal exchange rates are not aligned in the same direction. Thus, the results are quite different from the baseline subgroup differences in Fig. 4.

Third, countries in our sample are also differentially integrated to the US in terms of goods trade. Different degrees of trade integration may lead to these countries to be differentially sensitive to US financial uncertainty fluctuations. Trade integration with the US is measured from our trade data from IMF DOTS. Measure of trade integration is the total volume of trade (export and import) with the US as a ratio of total trade with the world averaged over our sample period.

Along with our Latin American sample, it is found that the Philippines, Taiwan, and Malaysia are also highly integrated with the US in terms of trade in goods. The group averages for the trade integration measures are presented to support such a sorting in Table A.5 in the online appendix and the subgroup estimation results are reported in Fig. 10. Note that in this

[29] For example, compared to others, East Asian countries are much more likely to borrow in Japanese Yen.

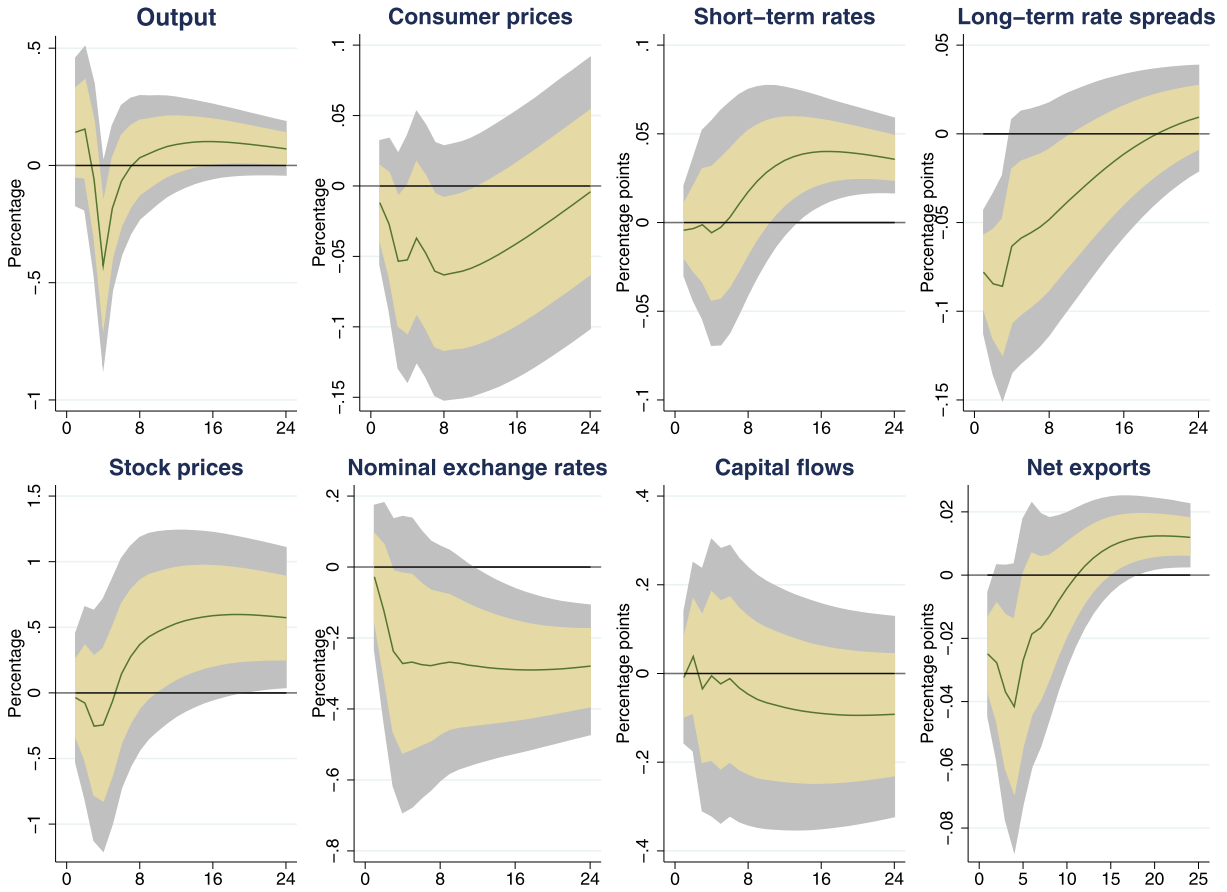

Fig. 9. Differential responses of the EM panel VAR to the US uncertainty shock: Countries with low trade integration (Group 2) minus Countries with high trade integration to the US (Group 1).
Notes: Each plot presents the posterior median of the differences of the impulse responses to a one-standard deviation shock to US uncertainty between the countries with low trade integration to the US (Group 2: India, Indonesia, Russia, South Africa, South Korea, Thailand, Turkey) and the countries with high trade integration to the US (Group 1: Brazil, Chile, Colombia, Malaysia, Mexico, Peru, the Philippines, Taiwan), along with the 68% and 90% error bands. See the notes in Fig. 4.

subgrouping, three more countries are added to the Latin American sample. Thus, compared to our baseline, if this was a more relevant sorting and mechanism, then one would expect to see more pronounced differences here in Fig. 10, compared to our baseline results in Fig. 4. What is found instead is that while output difference is in the similar direction (although smaller in peak difference), now the differences in stock prices and nominal exchange rates are no longer significant and the differences in short-term interest rates also weaker and less persistent. Thus, the heterogeneity in responses is quantitatively weaker, which provides some support for our baseline grouping, where it is Latin American EMEs vs. the rest of EMEs.

Among these alternative ways of grouping, the goods trade integration-based one deserves more attention since its results in Fig. 10 is similar to our baseline results in Fig. 4. This is not entirely surprising given the similarity in the composition of the subgroups between the two specifications. It should be noted however that important differences in terms of asset prices (stock prices and exchange rates) responses still exist. In order to assess the role of market integration further, in the online appendix, we rank the countries in terms of their service trade integration to the US using trade in services data available from UN COMTRADE. The resulting subgroups include Mexico, Colombia, Peru, Brazil, the Philippines, Chile and India in the highly integrated group in terms of service trade and the rest in Group 2. The results are presented in Fig. A.6 in the appendix, and they are quite different from the baseline. For example, in this case discernible differences in the response of capital flows are not found. This suggests that purely market integration based subgrouping does not necessarily align with the baseline pattern of heterogeneity emphasized in the paper.[30]

[30] Note that in both cases, output of countries that are more integrated with the US responds less strongly to the US uncertainty shock. Future work can explore if a model based interpretation of such an effect is possible.

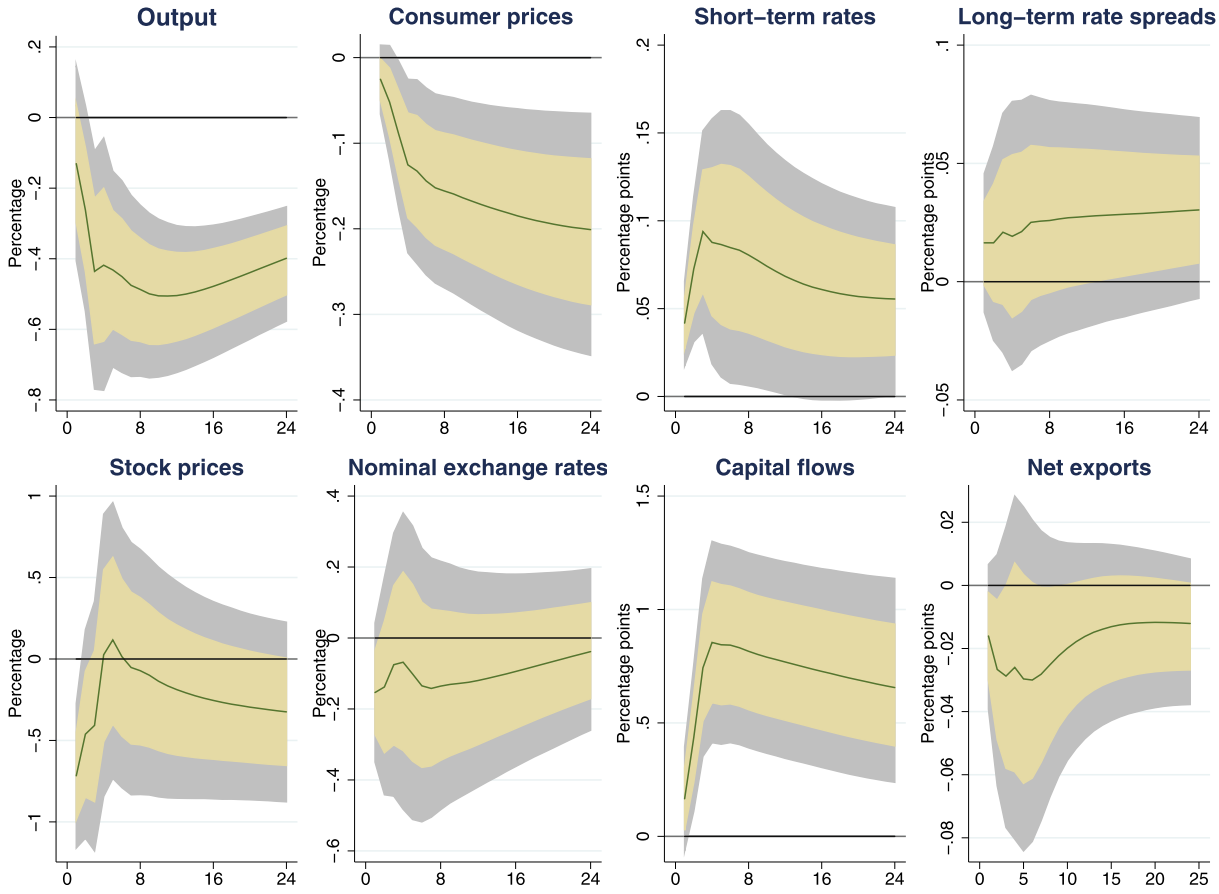

Fig. 10. Word counts reflecting concerns about capital flows in monetary policy minutes.
Notes: Each plot shows the relative frequency of capital flow words, compared to output stabilization words, in official central bank monetary policy minutes. Each dot corresponds to the minute of a meeting held in that date. A zero frequency means that there were no appearance of capital flow words in the corresponding minute. The orange line is the common mean for our sample of countries. See the text for discussion of capital flow and output stabilization words and the algorithm.

In our final alternative story, we consider sorting the countries according to their degree of fiscal imbalances and present these results in Fig. A.7 in the online appendix.[31] It is found that EMEs with higher fiscal imbalance have a bigger response to output but a smaller response of stock prices. Importantly, the short term interest rates respond similarly between the two subgroups. This analysis leaves differences in monetary policy reaction function as a plausible explanation for our observed pattern of heterogeneity in spillovers of US uncertainty.

5. Conclusion

US financial uncertainty leads to significant financial and macroeconomic spillover effects on emerging market economies (EMEs). An increase in US uncertainty negatively affects EME stock prices and exchange rates, raises EME country spreads, and decreases capital inflows into them. Moreover, it decreases EME output and consumer prices while increasing net exports. Importantly, economically meaningful heterogeneity is found in responses among the fifteen EMEs. The negative effects on output, exchange rates, and stock prices are weaker, but the effects on capital and trade flows stronger, for Latin American countries compared to other EMEs. The heterogeneity in effects across the two groups of EMEs is linked to their differential monetary policy response to the US uncertainty shock. Textual analysis of EME central bank minutes confirm that Latin American countries, compared to the other EMEs, pay less attention to smoothing capital flows.

Future work can explore if the spillovers effects of US uncertainty are also important for advanced small open economies, as suggested in Gerko and Rey (2017). Moreover, it can study how US financial uncertainty propagates to EMEs in a general equilibrium global economy with countries of different sizes where an increase in expected volatility in the stock markets of

[31] Bhattarai et al. (2017) find that domestic fiscal imbalances may matter for a country's vulnerability to an external monetary shock.

a large economy can lead to a flight to quality episode in EMEs, similar to Caballero and Krishnamurthy (2008). Finally, an even more comprehensive analysis of the EME central bank minutes to capture the "fear of capital flows", following analysis like Feroli et al. (2017), is part of our future research.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmoneco.2019.05.008.

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