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Market Whiplash After the 2025 Tariff Shock: An Event-Targeted VAR Approach*

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Abstract

On 2 April 2025, the U.S. President announced one of the largest tariff packages in history, triggering sharp financial market reactions. Yet within six weeks, markets had largely recovered. This paper develops an event-targeted vector autoregression (ETVAR) framework to disentangle three potential explanations for the recovery: the transitory nature of the initial shock, offsetting tariff announcements, and other macroeconomic surprises. Our orthogonalisation method isolates a dominant shock from the "Liberation Day" window and tracks its dynamic impact. Realisations of this orthogonalised shock explain 60–80% of the recovery in equities, copper prices, the VIX, and short-term inflation expectations. In contrast, the dollar's persistent depreciation and movements in government bond yields largely stem from other orthogonal shocks, coinciding with a sudden deterioration in Treasury market liquidity. The findings highlight the limits of attributing all market movements to trade policy and demonstrate the value of a flexible, event-driven orthogonalisation strategy.

Keywords: VAR, event-study, orthogonalisation, tariff announcements

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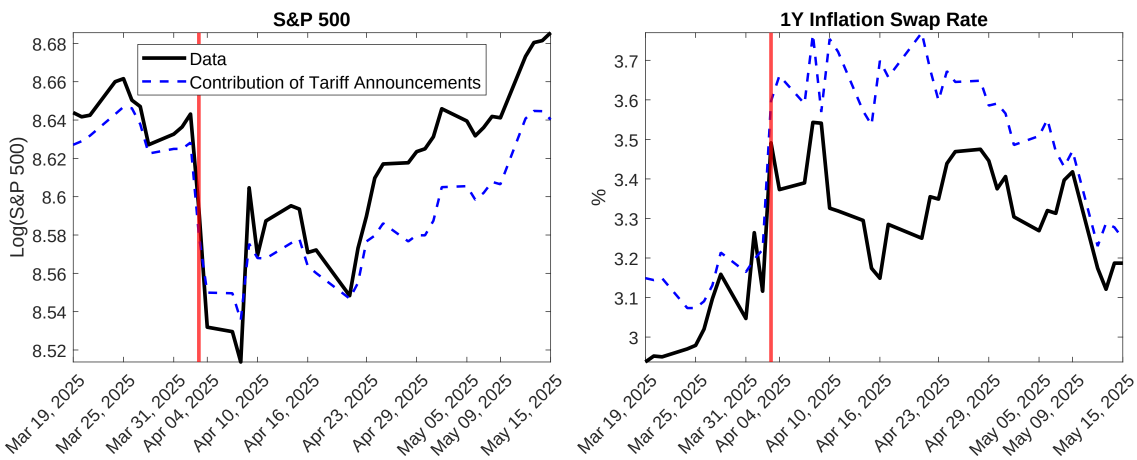
1 Introduction

The U.S. administration's tariff announcements on 2 April 2025 were among the largest in history. Financial markets reacted sharply: stock indices plunged, and short-term inflation expectations spiked. These initial reactions align with theoretical predictions that such announcements would reduce output and elevate inflation.[1] Yet, remarkably, within six weeks, markets had largely rebounded, with both equities and inflation expectations returning to pre-announcement levels, as illustrated by the solid black lines in Figure 1.

Figure 1: The sharp reaction and recovery in US markets



Notes: The solid black lines depict the time series of the S&P 500 index (in logs) and the 1-year inflation swap rate from 19 March 2025 to 15 May 2025. The blue dashed lines represent the counterfactual time series of these variables, as explained by tariff announcement shocks in our baseline ETVAR model, detailed in Section 2.

Why did financial markets stabilize so quickly despite the initial turmoil? There are at least three plausible explanations. First, the effects of the tariff announcement shock may have been highly transitory. Second, subsequent tariff announcements may have offset the initial negative impact.[2] Third, unrelated macroeconomic surprises may have counteracted the adverse effects of the tariff shock.[3] Disentangling these three explanations is essential for understanding the interplay between successive, often offsetting exogenous shocks and endogenous dynamics, as well as for drawing robust policy implications.

To address this, we employ an econometric framework which we label as event-targeted vector autoregressions (ETVAR). The approach constructs an orthogonalised shock ("tariff announcement shock") by minimising the distance between the counterfactual and observed

[1] See Kalemli-Ozcan et al. [2025], Alessandria et al. [2025], Auclert et al. [2025], Rodriguez-Clare et al. [2025], Ignatenko et al. [2025] among others.

[2] For example, the announcement on 9 April of a 90-day pause on tariff implementation triggered a reversal in some of the key variables.

[3] These surprises could include unexpectedly strong CPI or labour market data releases.

changes in the VAR variables over a specified time window (April 2–3, 2025). This ensures that the constructed shock is pinned down by the joint dynamics of the variables during this period. Once identified, the same shock vector is then traced forward and backward by the VAR to recover subsequent and previous realisations without any redefinition or adjustment. In this sense, the model provides a discipline: it allows us to detect surprise data movements at other points in time that reflect the same underlying economic force, provided they are consistent with the initial impulse.[4] By combining VAR dynamics with orthogonalization, the ETVAR framework is able to disentangle the contributions of (i) the initial shock, (ii) subsequent realisations from the same shock distribution, and (iii) other orthogonal shocks, thereby giving a more nuanced understanding than a simple event-study methodology.

Our baseline ETVAR model yields four main empirical results.[5] First, a single orthogonalised shock can explain a significant portion of the sharp reaction and subsequent recovery in key variables. For example, from the trough (8 April, 2025) to peak (15 May, 2025) the S&P 500 increased by about 0.17 log points, with the tariff announcement shock accounting for about 0.1 log points of this recovery (left panel of Figure 1). Similarly, tariff announcement shocks explain the majority of the total 39 bps fall in 1-year inflation swap rates over the same period (right panel of Figure 1). We obtain similar results for the VIX and copper prices as well.

Second, tariff announcement shocks fail to explain the persistent depreciation of the U.S. dollar. The initial depreciation during Liberation Day and subsequent realisations of the tariff shock contributed significantly to dollar volatility. However, the sharp 2.5% depreciation of the dollar over 10–11 April cannot be attributed to tariff announcement shocks. Instead, it appears to have been driven by other orthogonal forces, coinciding with an unexpected deterioration in Treasury market liquidity. These findings provide empirical support for Kashyap and Stein [2025]'s argument that the dysfunction in Treasury markets stems from deeper structural fragilities rather than tariff-related developments alone.

Third, while our baseline ETVAR model relies solely on variations in the data during the day following Liberation Day, the results indicate that some following surprises were interpreted as stemming from the same shock distribution. For instance, the shock peaks on 9 April and 12 May align with significant tariff-related developments, including the 90-day pause on tariff implementation and the temporary US-China tariff truce, respectively. This serves as a valuable cross-check, confirming that the force identified during Liberation Day is effectively captured

[4] This framework is general and can be applied to any economic events dominated by a unique economic shock, such as the Brexit referendum (23 June, 2016), whose economic properties one wish to uncover without employing ex ante restrictions.

[5] Our baseline VAR model uses daily data on seven variables: the S&P 500 index, the VIX, the 1-year Treasury yield, the 10-year minus 1-year Treasury term spread, copper prices, the 1-year inflation swap rate, and the USD-EUR exchange rate. The sample period spans from 1 January 2021 to 15 May 2025.

in later periods as well.

Fourth, we also assess the external validity of the identified shock by applying the impulse vector constructed from the April 2025 event window to the August 2019 tariff escalation. Strikingly, we find that the same shock explains a substantial share of the stock market movements in 2019—suggesting that the nature of the shock was not new in 2025. What sets the Liberation Day episode apart is not its structural novelty, but the exceptional magnitude of the shock.

Our ETVAR framework offers several advantages over standard event-study analysis and diff-in-diff approaches applied to the recent tariff announcements (e.g. Jiang et al., 2025, Hartley and Rebucci, 2025). It leverages the dynamic structure of the VAR model to trace the evolution of shocks and their effects over time. Moreover, the orthogonalisation process allows us to identify new realisations of shocks (possibly taking opposite signs) originating from the same distribution as the Liberation Day shock, providing a more nuanced understanding of subsequent market movements. As a result, unlike diff-in-diff methods, our approach does not require assumptions about the specific time horizon over which the treatment effect unfolds, making it more flexible in capturing the dynamic effects of economic shocks.

Related Literature The 2025 tariff announcements have sparked a growing body of literature, with most studies relying on structural models to estimate their effects (Kalemli-Ozcan et al., 2025, Alessandria et al., 2025, Auclert et al., 2025, Rodriguez-Clare et al., 2025, Ignatenko et al., 2025). While these structural approaches impose economic restrictions to identify the effects, our econometric approach offers a complementary perspective by being more data-driven, as is typical of VAR methodologies. At the same time, our empirical framework introduces structure to distinguish it from pure event-study methods (e.g. Jiang et al., 2025, Hartley and Rebucci, 2025) as discussed above.

Our methodology contributes to a growing literature on shock identification using event-related restrictions (Ludvigson et al., 2017, 2021, Antolin-Diaz and Rubio-Ramirez, 2018, Ben Zeev, 2018). These studies often begin with identified structural shocks (e.g. monetary policy surprises) and use specific events or time periods dominated by these shocks to enhance identification. In contrast, we identify an orthogonalised shock by selecting the linear combination of VAR innovations that best explains the joint movement of key variables over a pre-specified event window, without imposing prior beliefs on the direction or economic interpretation of the shock. This event-targeted orthogonalisation is therefore highly agnostic as it avoids imposing economic restrictions on the effects of the shock (Uhlig, 2005).

The agnostic nature of our approach is similar to that of Uhlig [2004], Barsky and Sims [2011], Angeletos et al. [2020], whose orthogonalisation relies on the contribution of shocks to the forecast error variance of specific variables over various horizons. In contrast, our orthogonalisation relies on the historical contribution of a shock to the time path of variables.[6] In this sense, our method can be viewed as an agnostic extension of the high-frequency approach used to identify monetary policy shocks (Kuttner, 2001, Bernanke and Kuttner, 2005, Gürkaynak et al., 2005, Nakamura and Steinsson, 2018, Cieslak and Schrimpf, 2019, Jarocinski and Karadi, 2020, Miranda-Agrippino and Ricco, 2021, Bauer and Swanson, 2023).

The closest work to ours is the unpublished manuscript of Pinter [2018] which constructs orthogonalised shocks to explain the time path of aggregate consumption growth during the Great Recession. In contrast, our paper constructs a shock that explains the dynamic behaviour of *all* VAR variables within a targeted time window.

2 Empirical Methodology

We consider an n-dimensional vector autoregressive model of order p, VAR(p), for a vector of variables $\mathbf{y}_t \in \mathbb{R}^n$:

$$\mathbf{y}_t = A_1\mathbf{y}_{t-1} + \cdots + A_p\mathbf{y}_{t-p} + \boldsymbol{\mu} + \mathbf{u}_t, \quad \mathbf{u}_t \sim \text{i.i.d. } (\mathbf{0}, \Sigma_u) \tag{2.1}$$

where $A_1, \ldots, A_p$ are $n \times n$ matrices of coefficients, $\boldsymbol{\mu}$ is a vector of constants, and $\mathbf{u}_t$ contains vectors of reduced-form residuals with zero mean and positive definite covariance matrix Σ_u. The reduced-form residuals are assumed to be linear transformation of economically fundamental shocks, $\boldsymbol{\varepsilon}_t$:

$$\mathbf{u}_t = B\boldsymbol{\varepsilon}_t, \quad \boldsymbol{\varepsilon}_t \sim \text{i.i.d. } (\mathbf{0}, I_n) \tag{2.2}$$

where B is an $n \times n$ matrix satisfying $BB' = \Sigma_u$, with each $\mathbf{b}_j \in \mathbb{R}^n$ in $B = \begin{bmatrix}\mathbf{b}_1 & \mathbf{b}_2 & \cdots & \mathbf{b}_n\end{bmatrix}$ representing the contemporaneous impulse of the j-th orthogonalised shock. The economic shocks ε_t are assumed to be of independent origins and normalised to have unit variance, captured by the identity covariance matrix, I_n (Sims, 1980, Ramey, 2016). As well known in the literature, the transformation (2.2) is not unique, therefore additional restrictions are required.

Event-targeted orthogonalisation Our method proposes to find an orthogonal shock by restricting a subset of the matrix B based on the (Wold) moving average representation of the VAR. The decomposition gives the dynamics of $\mathbf{y}_t$ in terms of deterministic components and

[6]Our method also bears some resemblance to other agnostic identification approaches (Rigobon, 2003, Lewis, 2021), though we differ in targeting dominant shock contributions within a pre-specified event window rather than exploiting heteroskedasticity or external moment conditions. Our approach to finding a single orthogonalised shock shares some conceptual similarity with Stock and Watson [2025] who analyse a single (COVID) factor within a dynamic factor model framework.

past shocks:

$$\mathbf{y}_t = \boldsymbol{d_t} + \sum_{i=0}^{\infty} \Phi_i B \boldsymbol{\varepsilon}_{t-i}, \tag{2.3}$$

where $\boldsymbol{d_t}$ is the contribution of the intercepts and the initial values, and Φ_i are $n \times n$ moving average coefficient matrices capturing the propagation of shocks over time.[7] Our method relies on constructing an impulse vector $\mathbf{b}^\star$ to build counterfactual historical time-series written as:

$$\tilde{\mathbf{y}}_t = \boldsymbol{d_t} + \sum_{i=0}^{\infty} \Phi_i \tilde{B} \boldsymbol{\varepsilon}_{t-i}, \tag{2.4}$$

where $\tilde{B} = [\mathbf{b}^*, 0, 0..., 0]$. Intuitively, (2.4) builds a counterfactual time-series that would have realised if only one orthogonalised shock (corresponding to the impulse vector $\mathbf{b}^*$) had been in operation with all other orthogonalised shocks shut down. We propose to find this orthogonal economic force by minimising the distance between the changes in the counterfactual VAR variables and changes in the actual variables over a specified time horizon (between dates t_1 and t_2). Formally:

$$\mathbf{b}^\star = \arg\min_{\mathbf{b} \in \mathbb{R}^n} |\Delta \mathbf{y}_{t_1:t_2} - \Delta \tilde{\mathbf{y}}_{t_1:t_2}| \oslash \Lambda, \tag{2.5}$$

where $\oslash$ denotes element-wise division, and $\Lambda \in \mathbb{R}^n$ is a scaling vector to bring the VAR variables to a common unit measure.[8] In our baseline application, we set t_1 and t_2 such that the event window is from 2 April to April 3. Details of the numerical implementation of the optimisation problem (2.5) are provided in Appendix A.2. The proposed orthogonalisation scheme is general, and could be used to estimate the dynamic effects of orthogonal economic forces that dominated variations in the data (relative to other orthogonal shocks) during specific time-windows.[9]

[7]These matrices Φ_i are recursively defined by:

$$\begin{aligned}
\Phi_0 &= I_n, \\
\Phi_1 &= A_1, \\
\Phi_2 &= A_1\Phi_1 + A_2, \\
&\vdots \\
\Phi_h &= A_1\Phi_{h-1} + A_2\Phi_{h-2} + \cdots + A_p\Phi_{h-p} \quad \text{for } h \geq p.
\end{aligned}$$

[8]In our application, we use the measured standard deviation of the growth rate of the VAR variables.

[9]For example, events such as the Brexit referendum (23 June, 2016) represent another natural application of our method. Pinter et al. [2025] applies the method to study the fiscal theory of the price level.

3 Empirical Results

Data Our baseline VAR is estimated at a daily frequency over the sample period from 1 January 2021 to 15 May 2025. The model includes seven variables: the log of the S&P 500 index, the log of the VIX, the 1-year Treasury yield, the 10-year minus 1-year Treasury term spread, the log of copper prices, the 1-year inflation swap rate, and the USD/EUR exchange rate. The exact data sources are provided in Appendix A.1. The swap rate proxies high-frequency changes in inflation expectations, and copper prices are included as a business cycle indicator (Fama and French, 1988, Labys et al., 1999). Our baseline VAR includes eight lags, but our main results are robust to using fewer or more lags (see Appendix A.3).

Impulse response function Figure 2 displays the impulse response functions following a tariff announcement shock, which is normalised to induce a one-log-point increase in the VIX.[10] The S&P 500 index falls immediately by approximately 13%, with some reversal occurring over the next 30 days. Copper prices drop by more than 5% on impact[11] and the 1-year inflation swap rate jumps by around 100 bps. These stagflationary effects align with the predictions of recent theoretical models (Auclert et al., 2025) and anecdotal reports of stagflation fears in market commentary.

Short-term rates drop by around 30 bps, indicating that growth concerns would dominate inflation fears in the central bank's perceived reaction function (Taylor, 1993). The term spread shows little immediate reaction but subsequently steepens, reaching a peak of around 20 basis points four days after the shock. Expected monetary policy loosening leads the dollar to depreciate. Though note that the depreciation of approximately 5% (remaining persistent over the 30-day horizon) is large relative to the movements in yields. Overall, these impulses could be rationalised with recent theoretical models of tariff policy under specific scenarios.[12]

Historical decompositions To understand the stochastic drivers of the data following Liberation Day, we conduct historical decompositions (Figures 3 and 4). This allows us to distinguish among the effects of (i) the initial tariff shock, (ii) subsequent realisations of the tariff-shock, and (iii) other macroeconomic shocks orthogonal to tariff policy.

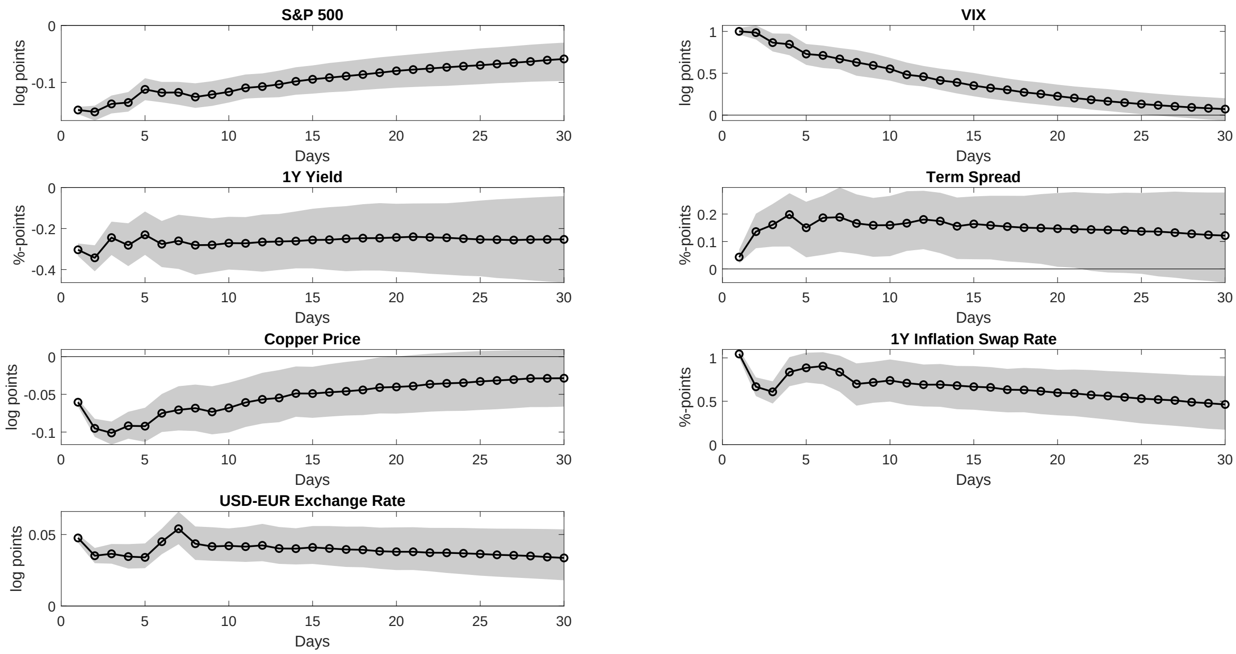
Importantly, our methodology constructs the orthogonalised tariff shock using information exclusively from the April 2–3 window. This means that the shock series are pinned down entirely by the joint dynamics of the variables during that 24-hour period. Once identified,

[10] The cumulative change in the VIX four days after the announcement was close to 1 log point.

[11] Copper prices continue to fall for the following two days, leading to a cumulative impact of 10%.

[12] While most theoretical models cited above predict stagflationary impulses of the tariff shock, consistent with Figure 2, Kalemli-Ozcan et al. [2025], for example, also shows that expected retaliation or uncertainty could generate sizeable depreciation of the dollar as well.

Figure 2: The impulse response functions for a tariff announcement shock



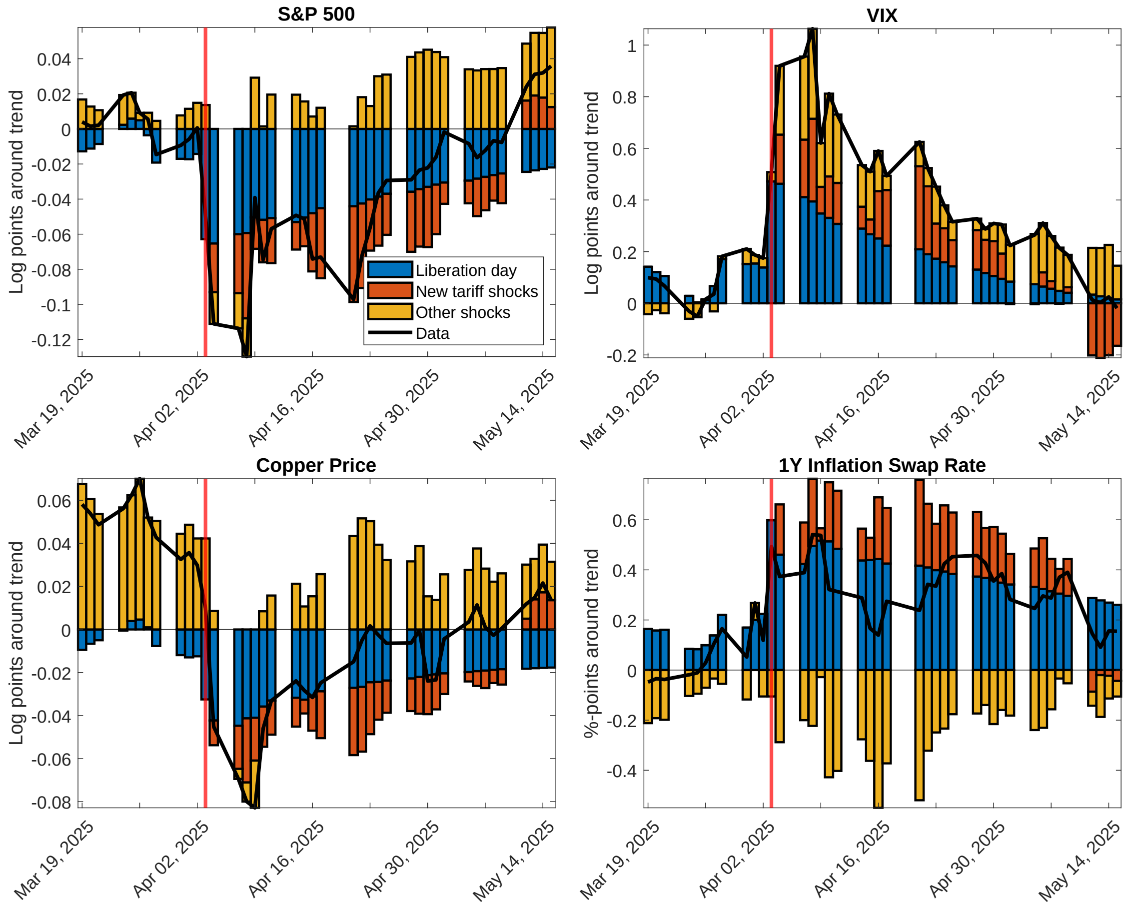
Notes: The figure presents impulse response functions for a tariff announcement shock that is normalised to increase the VIX by one log points. The VAR is estimated using using Bayesian methods (Banbura et al., 2010) with flat priors. The VAR includes eight lags and is estimated at a daily frequency over the sample period from 1 January 2021 to 15 May 2025. The shaded area represents 10-90% probability bands.

the same shock vector is then traced forward by the VAR to recover subsequent realisations without requiring redefinition. The emergence of sizeable red bars in the historical decompositions on April 9 and May 12 – coinciding with key tariff-related developments – serves as a validation of this structure. These results suggest that our method successfully captures economically meaningful evolutions of the initial shock, thereby demonstrating its empirical power and interpretive clarity.

Figure 3 shows the decompositions for the S&P 500 index, the VIX index, copper prices and short-term inflation expectations measured by the 1-year inflation swap rate. Movements in these variables were partially driven by the decaying effects of the initial announcement (blue bars) and new tariff announcement shocks (red bars). Notably, the realisations on 9 April and 12 May were key drivers of the recovery, as these dates coincided with the announcement of a 90-day pause on tariff implementation and the temporary US-China tariff truce, respectively.

Other macroeconomic shocks, orthogonal to the tariff announcement shock, also played a significant role in driving the recovery of key variables. For instance, downward pressure on inflation expectations (represented by the negative yellow bars in the bottom left corner of Figure 3) can be attributed to favourable macroeconomic developments. This aligns with three successive CPI data releases between March and May that were generally more favourable than

Figure 3: Historical decomposition: stock market, copper prices and inflation expectations

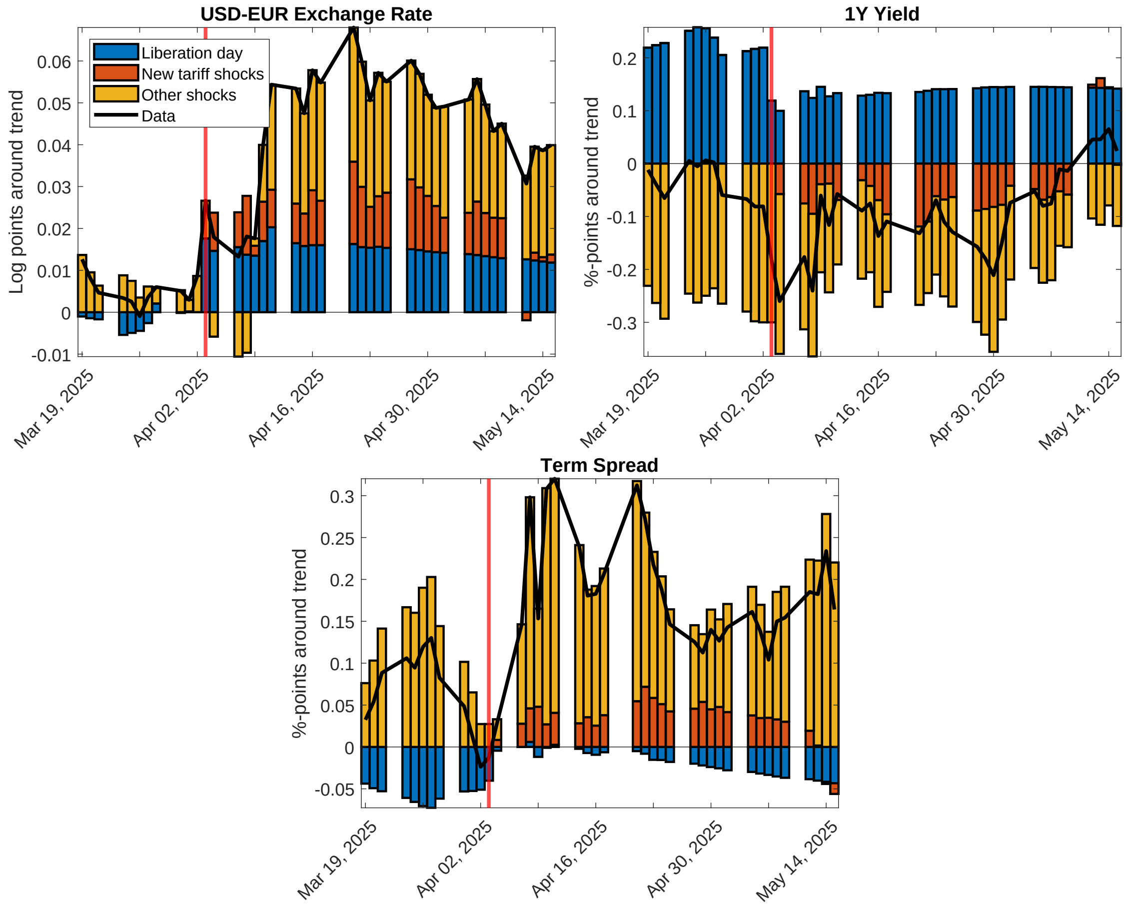


Notes: The figure presents historical decompositions of the VAR variables for the period 2025 Mar 19 – 2025 May 15. The blue bars represent the contribution of the tariff announcement shocks that were realised till 3 April 2025. The red bars represent the contribution of new tariff announcement shocks that realised after 3 Apr 2025. The yellow bars represent the contribution of all other orthogonalised shocks in the VAR. The black lines show the detrended data (using the deterministic component of the VAR for detrending, i.e. $\boldsymbol{d_t}$ in 2.3). By the nature of the orthogonalisation method, the change in the data from 2 April (marked by the red vertical line) to 3 April is driven solely by changes in the blue bars.

anticipated (BLS, 2025a). Additionally, late April and early May brought positive surprises in output and labour market data (BLS, 2025b). Consistent with these developments, our decomposition reveals that a substantial portion of the recovery in the S&P 500 and copper prices was amplified by the contribution of these orthogonal shocks.

The role of other orthogonal shocks becomes even more evident in explaining the persistent depreciation of the dollar, which the tariff announcement shocks fail to account for (Figure 4). In particular, the sharp dollar depreciation observed during the two-day period of 10–11 April is attributed to shocks orthogonal to tariff-related surprises. This period coincided with a rapid deterioration in Treasury market liquidity. These were driven by concerns over the unwinding of leveraged positions and a shifting perception of U.S. fiscal sustainability (Liang, 2025, Perli, 2025). Consistent with this, the term spread jumped on 10–11 April, driven by spiking long-

Figure 4: Historical decomposition: the U.S. dollar and the Treasury market



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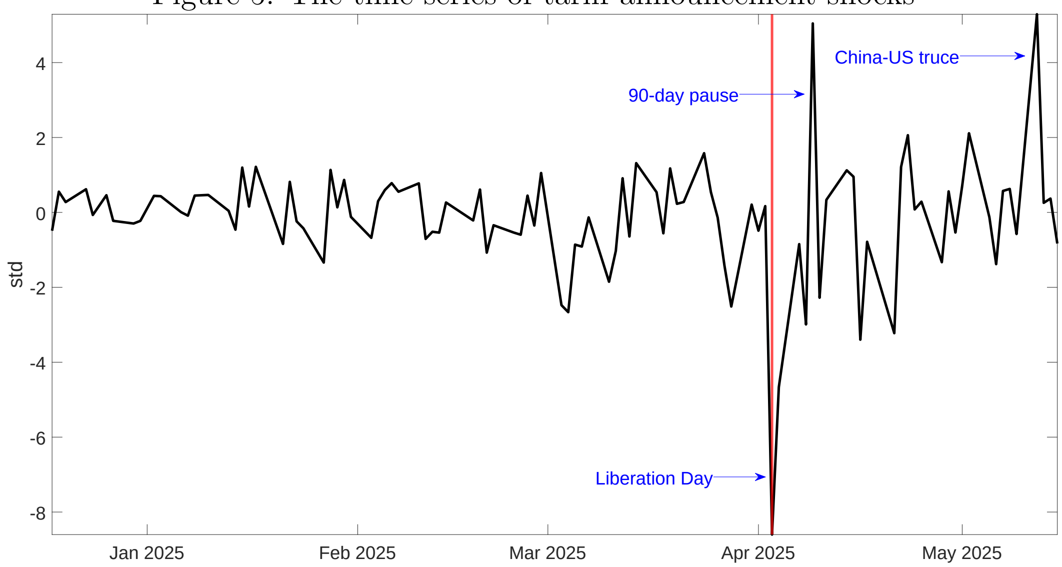
term Treasury yields, which were explained by shocks orthogonal to tariff shocks (marked by the yellow bars). These orthogonal shocks accounted for most of the variation in the term spread during this period. These findings align with the broader narrative that problems in the government bond market extend beyond tariff announcements, as "dysfunction lies at the heart of the Treasury market" (Kashyap and Stein, 2025).

An interesting finding is that the tariff announcement shocks are also relevant to explaining movements in the data before Liberation Day. For example, these shocks contributed to the rise in short-term inflation expectations and 1-year yields (Figures 3–4) before 2 April. This is consistent with the increasing relevance of tariff-related policy measures since the election of the recent administration (Miran, 2024). To explore this further, we now turn to analysing the historical behaviour of the shock.

Inspecting the time-series of tariff announcement shock It is revealing to inspect the time-series of the tariff announcement shock. Figure 5 shows the time-series during the last 120 days of our sample. The shock series is generally much less volatile before Liberation day, but its volatility increases as we get closer to Liberation day, suggestive of increased uncertainty about tariff policy.

The shock peaks (in absolute value) on 3 April when it dropped by around 8.7 standard deviations. While the orthogonalisation is based purely on the dynamics of variables during 2-3 April, 2025, the shock series spikes on 9 April and 12 May (by about 5 standard deviations) as well when tariff news dominated market movements: the announcement of a 90-day pause on the implementation of Tariffs and the temporary US-China truce, respectively. While these two days are not used in the orthogonalisation, it is reassuring that our method picks up these two days as market commentary strongly suggests that movements in financial markets were dominated by positive tariff news during these periods.

Figure 5: The time-series of tariff announcement shocks



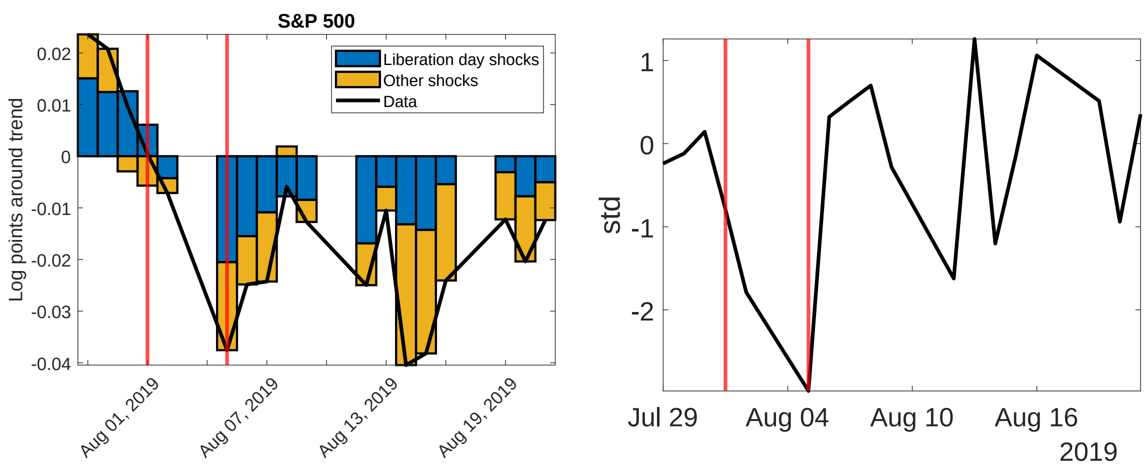
Notes: The figure presents the time-series of the orthogonalised tariff announcement shock obtained from our baseline VAR, which includes eight lags and is estimated at a daily frequency over the sample period from 1 January 2021 to 15 May 2025.

Note that the shock is relatively muted on 10-11 April, when Treasury market liquidity problems intensified and dollar depreciated sharply, and the US's exorbitant privilege came into question (Brooks, 2025). This is consistent with the historical decomposition above, showing that realisations of other orthogonal shocks (which we do not identify) are driving the sharp changes in Treasury markets and the dollar on 10-11 April.

External Validity: the 2019 August tariff announcements To provide additional external validity, we revisit tariff announcements from a previous U.S. administration through the lens of our orthogonalisation framework. Specifically, we examine whether the orthogonalised shock identified for 2–3 April 2025 can explain movements in the data during 1–5 August 2019, a period similarly dominated by tariff-related events (Bown, 2019). This exercise demonstrates the strength of the ETVAR framework in assessing whether two seemingly similar events are driven by the same underlying economic force (albeit of different magnitudes) or by structurally distinct shocks.

The focus on 1–5 August 2019 is motivated by the significant financial market volatility during this period. On August 1, 2019, the U.S. president announced a 10% tariff on $300 billion of Chinese imports, and on August 5, 2019, the Chinese Commerce Ministry responded by halting imports of all American agricultural goods. These announcements triggered a sharp contraction in equity markets, making this period an ideal candidate for comparison.

Figure 6: Revisiting the tariff announcements of August 2019



Notes: The left panel presents historical decompositions from the VAR that is reestimated for the period 2017 Jan 1 – 2019 Dec 31. The decomposition of the S&P 500 is plotted over the period 2019 Jul 29 – 2019 Aug 31. The blue bars represent the contribution of the tariff announcement shocks as constructed in our baseline model targeted at 3 April 2025. The yellow bars represent the contribution of all other orthogonalised shocks in the VAR. The black lines show the detrended data (using the deterministic component of the VAR for detrending, i.e. $\boldsymbol{d_t}$ in 2.3). The first red vertical line marks August 1, 2019 when the U.S. president announced that he would impose a 10% tariff on $300 billion of Chinese imports beginning September 1. The second red vertical line marks August 5, 2019 when the Chinese Commerce Ministry announced that China was halting imports of all American agricultural goods. The right panel shows the time-series of the orthogonalised shock over the same period.

To evaluate whether these events were driven by the same economic force as the 2025 Liberation Day events, we use the estimated impulse vector $\mathbf{b}^*$ from our baseline VAR, obtained by minimising the objective function (2.5). We then recompute the historical decomposition (2.4) for the earlier period, covering 1 January 2017 to 31 December 2019. This sample differs from our baseline (1 January 2021 to 15 May 2025), and the terms $\boldsymbol{d_t}$ and Φ_i in (2.4) need to be re-estimated based on the earlier data which introduces limitations to this exercise.[13]

[13]We exclude the COVID-19 period (2020) to avoid additional complexities that would require special treatment (Lenza and Primiceri, 2022).

Despite these limitations, Figure 6 reveals that a significant portion of the sharp stock market reaction in early August 2019 was driven by the same orthogonal force as the one underlying Liberation Day. The left panel of Figure 6 shows a historical decomposition, confirming that the tariff announcement shock explains the majority of the 5% drop in the equity index during this period. The right panel highlights three successive negative realisations of the tariff announcement shock between 1–5 August 2019.

While the August 2019 episode echoes Liberation Day, it is quantitatively far less volatile. The largest shock during this period was approximately 3 standard deviations, which pales in comparison to the 8.7 standard deviation shock observed after Liberation Day in 2025. This suggests that what sets Liberation Day apart is not the novelty of the economic shock itself, but rather the unprecedented magnitude of the 2025 shock, which far exceeded the intensity of earlier realisations.

Orthogonalisation based on multiple tariff announcements In our baseline ETVAR model, the tariff shock is constructed using data from the window spanning 2–3 April 2025. A reassuring finding is that the constructed shock series also spikes on 9 April (90-day pause) and 12 May (US-China truce), suggesting that the same economic force was at play during these episodes (as shown in Figure 5). If these additional event windows were indeed driven by the same economic force as Liberation Day, the model should be able to incorporate them into the orthogonalisation without materially altering the baseline impulse vector and its dynamic implications.

To formally check this, we extend the ETVAR objective function 2.5 to jointly target these three event windows:

$$\mathbf{b}^{\star} = \arg\min_{\mathbf{b}\in\mathbb{R}^n} \left\{ \begin{array}{l} \quad \left|\Delta\mathbf{y}_{04/02:04/03} - \Delta\tilde{\mathbf{y}}_{04/02:04/03}\right| \oslash \Lambda \\ + \left|\Delta\mathbf{y}_{04/08:04/09} - \Delta\tilde{\mathbf{y}}_{04/08:04/09}\right| \oslash \Lambda \\ + \left|\Delta\mathbf{y}_{05/09:05/12} - \Delta\tilde{\mathbf{y}}_{05/09:05/12}\right| \oslash \Lambda \end{array} \right\}. \tag{3.1}$$

We find that the shock series from this multi-event orthogonalisation is more than 99% correlated with the baseline shock series depicted in Figure 5. Moreover, the obtained impulse response functions are virtually identical to those in our baseline, as shown in Appendix Figure 12. These results provide numerical evidence that the sharp joint reactions of the VAR variables during these three distinct episodes are driven by the same underlying economic force, rather than unrelated shocks that happened to align.

More broadly, this extension illustrates the modular extensibility of the ETVAR framework: it can be adapted to test whether different episodes share a common structural driver, or whether additional shocks are needed to explain the observed dynamics.

4 Conclusions

This paper has examined the macro-financial impact of the 2025 U.S. tariff announcements using an event-targeted vector autoregression (ETVAR) framework. Our findings reveal that a single economic force explains much of the sharp reaction and subsequent recovery in equity prices, VIX, copper, and short-term inflation expectations. These effects align with the characteristics of a stagflationary policy shock, which was partially offset by subsequent policy reversals and favourable macroeconomic surprises.

However, the framework also underscores the limits of attributing all asset price movements to trade policy. Treasury yields and the U.S. dollar, while initially influenced by tariff announcements, responded strongly to other disturbances—particularly during the 10–11 April period. These results provide empirical support for Kashyap and Stein [2025]'s argument that structural fragilities in the Treasury market, rather than trade policy alone, are increasingly driving yield dynamics. The findings underscore that a single economic force cannot fully explain the joint evolution of all asset classes – particularly the Treasury market and FX – highlighting the need to model multiple shocks in this episode.

Methodologically, the ETVAR framework complements existing event-study and structural VAR approaches by isolating shocks based on within-window data comovement, without relying on restrictive assumptions such as sign restrictions or exclusion criteria. This makes it particularly well-suited for studying large, sudden, and dominant policy shocks.

That said, our approach has limitations. Like most VAR-based methods, it assumes linear propagation of shocks and does not account for potential nonlinear feedback loops or structural breaks. For instance, the Liberation Day episode may have coincided with a deeper regime shift related to the dollar's international role or global perceptions of U.S. policy credibility (Harvey et al., 2025). Extending the ETVAR framework to incorporate nonlinear dynamics or jointly identifying multiple orthogonal shocks would be a promising avenue for future research.

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A Appendix

A.1 Data Sources

Our baseline ETVAR model employs daily data for seven key variables, covering the period from January 1, 2021, to May 15, 2025. Data on the S&P 500 Index is sourced from the Federal Reserve Economic Data (FRED) database under the series code `SP500`. For the CBOE Volatility Index (VIX), we use daily data obtained from the FRED database under the series code `VIXCLS`.

U.S. Treasury yields are sourced from Refinitiv, specifically the 1-year (`US1YT=RR`) and 10-year (`US10YT=RR`) Treasury yields. These yields represent the midpoint of the bid and ask rates (`MID_YLD_1`). The term spread is calculated as the difference between the 10-year yield and the 1-year yield. Copper prices are obtained from the London Metal Exchange (LME) via Refinitiv, using the official settlement price of the 3-month forward contract, identified by the Eikon code `CMCU3-PD`.

We include data on the 1-year U.S. CPI inflation swap rate, which is sourced from Refinitiv under the series code `USCPIZ1Y=`. Finally, the USD-EUR exchange rate is represented by the closing mid-price, also sourced from Refinitiv under the series code `EUR`.

A.2 Numerical Implementation

The numerical implementation of the optimisation problem (2.5) starts with the linear transformation $B = CQ$ where C is the lower-triangular Cholesky matrix (or Cholesky factor) such that $\Sigma_u = CC'$, and Q is an $n \times n$ orthonormal matrix. A matrix $Q \in \mathbb{R}^{n\times n}$ is orthonormal if its columns (or rows) are orthogonal unit vectors, meaning:

$$Q^T Q = QQ^T = I_n$$

To minimise (2.5) for an n-variable VAR, we construct matrix Q by appropriately rotating the n-dimensional space with the optimal choice the Euler angles. A rotation in n-dimensional space is defined by a plane of rotation and an angle. For example, a rotation in the plane spanned by the i-th and j-th axes (where $1 \le i < j \le n$) is represented by a generalized rotation matrix $R_{ij}(\theta)$, which is an $n \times n$ matrix with θ being an Euler angle.

The generalized rotation matrix $R_{ij}(\theta)$ rotates vectors in the i-j plane by an angle θ, leaving all other components unchanged. It is defined as:

$$R_{ij}(\theta)_{pq} = \begin{cases} 1, & \text{if } p = q \text{ and } p \notin \{i, j\}, \\ \cos\theta, & \text{if } p = q = i \text{ or } p = q = j, \\ \sin\theta, & \text{if } (p, q) = (i, j), \\ -\sin\theta, & \text{if } (p, q) = (j, i), \\ 0, & \text{otherwise.} \end{cases}$$

In matrix form, $R_{ij}(\theta)$ is an identity matrix with the following modifications to the i-th and j-th rows and columns:

$$R_{ij}(\theta) = \begin{bmatrix} 1 & & & & & & \\ & \ddots & & & & & \\ & & \cos\theta & \cdots & \sin\theta & & \\ & & \vdots & \ddots & \vdots & & \\ & & -\sin\theta & \cdots & \cos\theta & & \\ & & & & & \ddots & \\ & & & & & & 1 \end{bmatrix}$$

Here, the non-trivial entries are located in the i-j plane.

To construct an orthonormal matrix in n-dimensional space, we multiply a sequence of generalized rotation matrices. Let $\theta_1, \theta_2, \ldots, \theta_k$ be the angles of rotation, and let the rotations occur in planes $(i_1, j_1), (i_2, j_2), \ldots, (i_k, j_k)$. The resulting orthonormal matrix Q is:

$$Q = R_{i_k j_k}(\theta_k) R_{i_{k-1} j_{k-1}}(\theta_{k-1}) \cdots R_{i_1 j_1}(\theta_1) \tag{A.1}$$

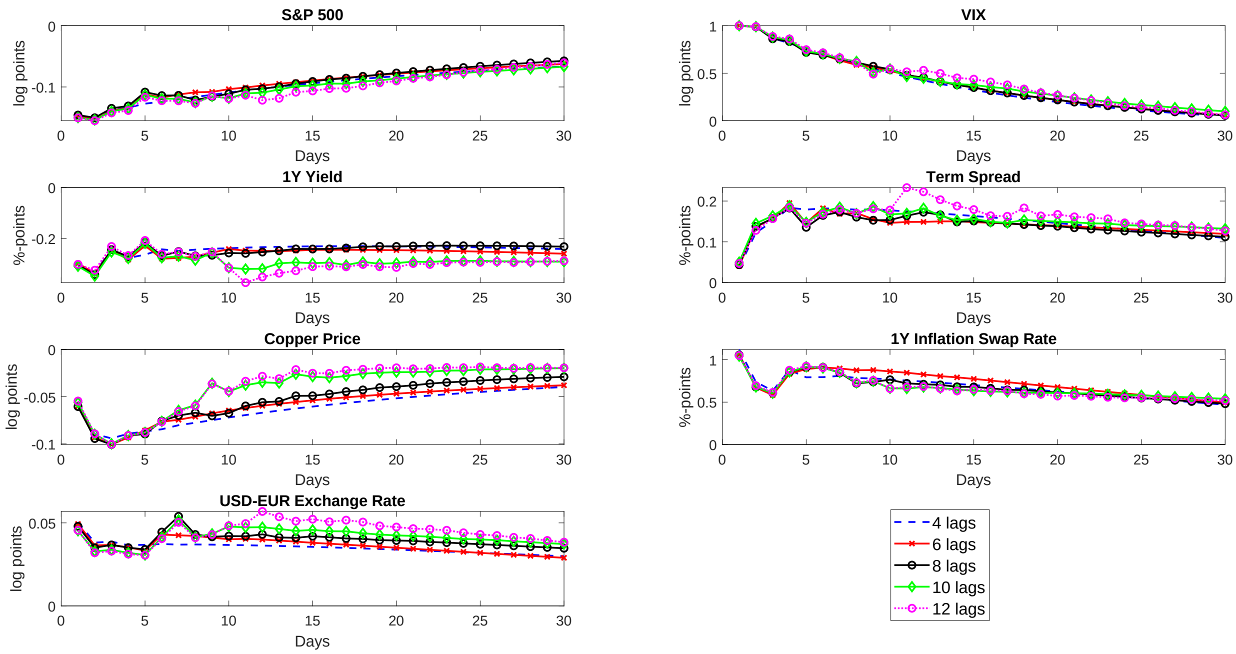
In our baseline (7-variable) VAR model, we need to find $n(n-1)/2$ Euler angles (21 parameters) to minimise the objective function (2.5).

A.3 *Robustness to VAR Lag Length*

A.3.1 *Impulse Response Function*

Our baseline VAR uses 8 lags. This section presents impulse response functions and historical decompositions for alternative lag lengths: fewer (6) and more (10).

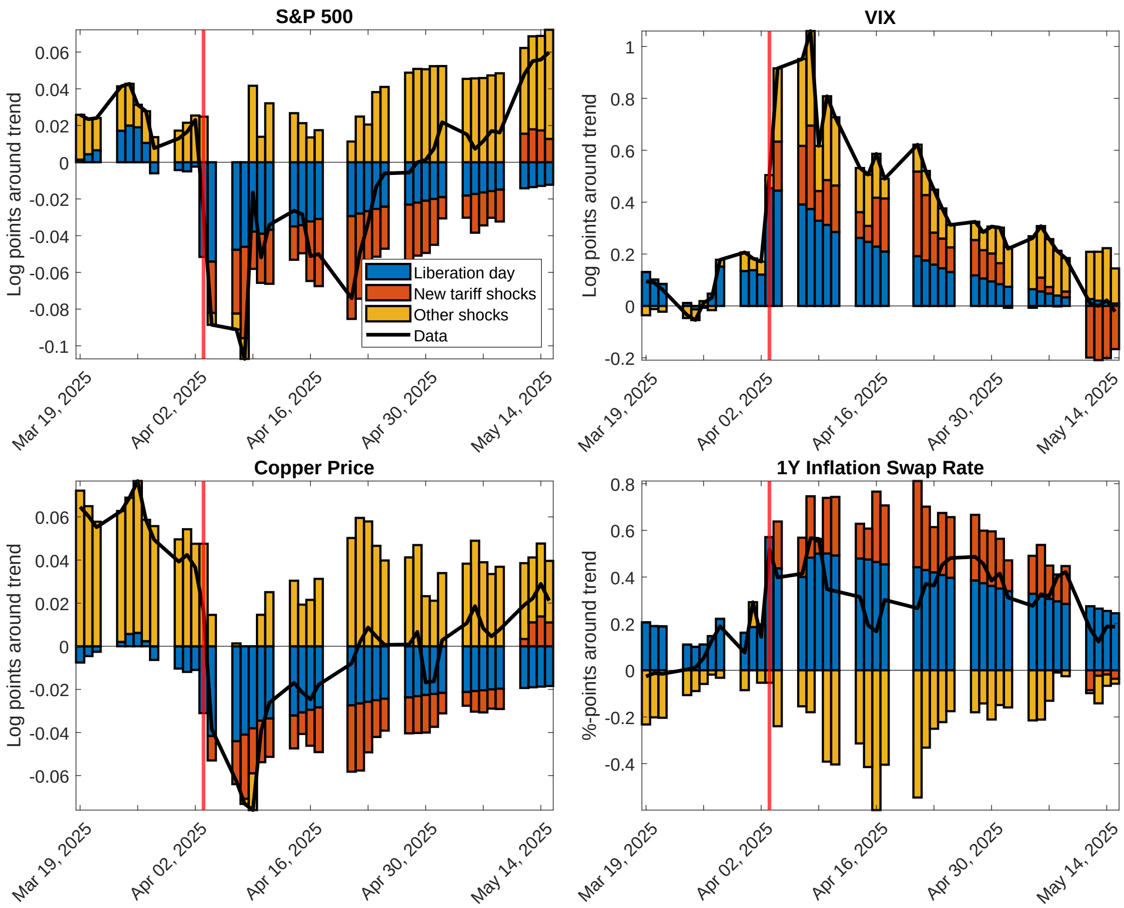
Figure 7: The impulse response functions: robustness to lag length



Notes: The figure presents impulse response functions for a tariff announcement shock that is normalised to increase the VIX by one log points. The OLS point estimates are shown for VARs of different lag length.

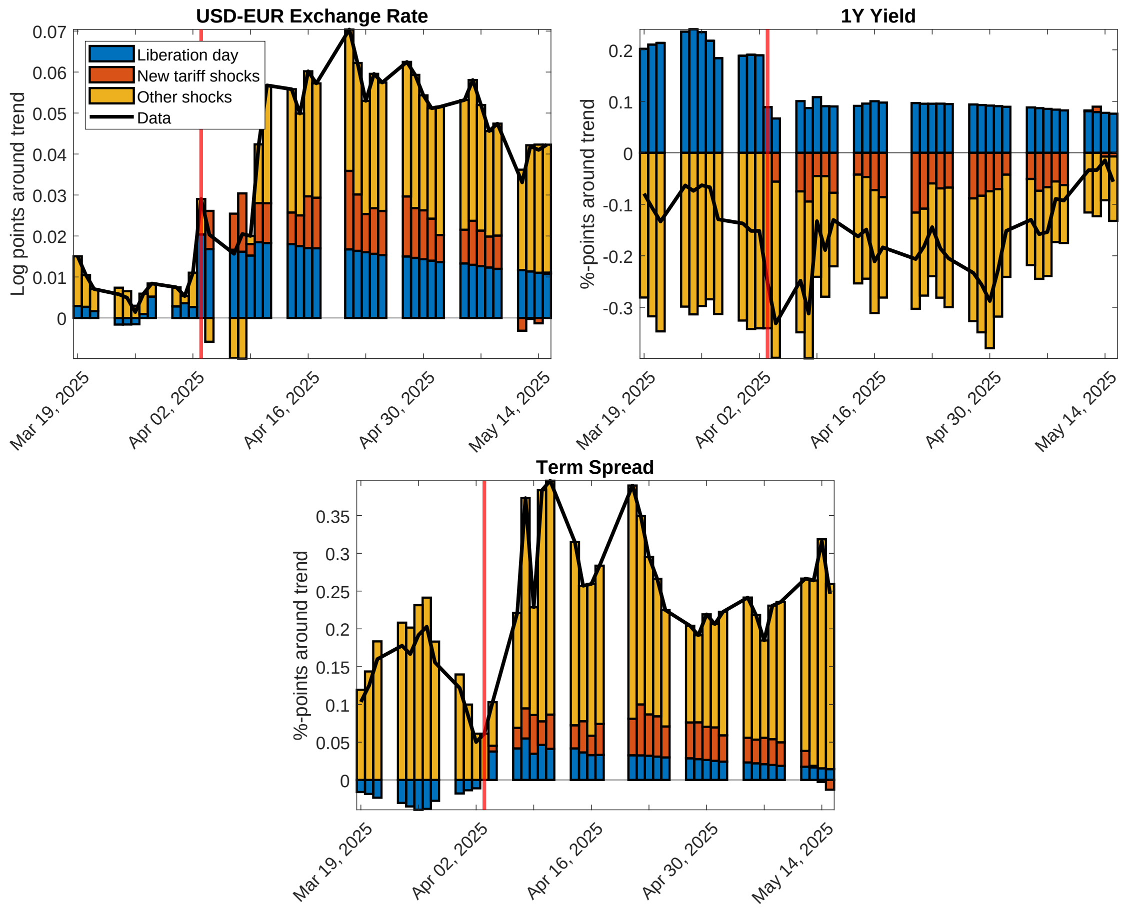
A.3.2 Historical Decompositions from a VAR(6)

Figure 8: Historical decomposition: stock market, copper prices and inflation expectations



Notes: The figure presents historical decompositions of the VAR variables for the period 2025 Mar 19 – 2025 May 15. The blue bars represent the contribution of the tariff announcement shocks that were realised till 3 April 2025. The red bars represent the contribution of new tariff announcement shocks that realised after 3 Apr 2025. The yellow bars represent the contribution of all other orthogonalised shocks in the VAR. The black lines show the detrended data (using the deterministic component of the VAR for detrending, i.e. $\boldsymbol{d_t}$ in 2.3). By the nature of the orthogonalisation method, the change in the data from 2 April (marked by the red vertical line) to 3 April is driven solely by changes in the blue bars.

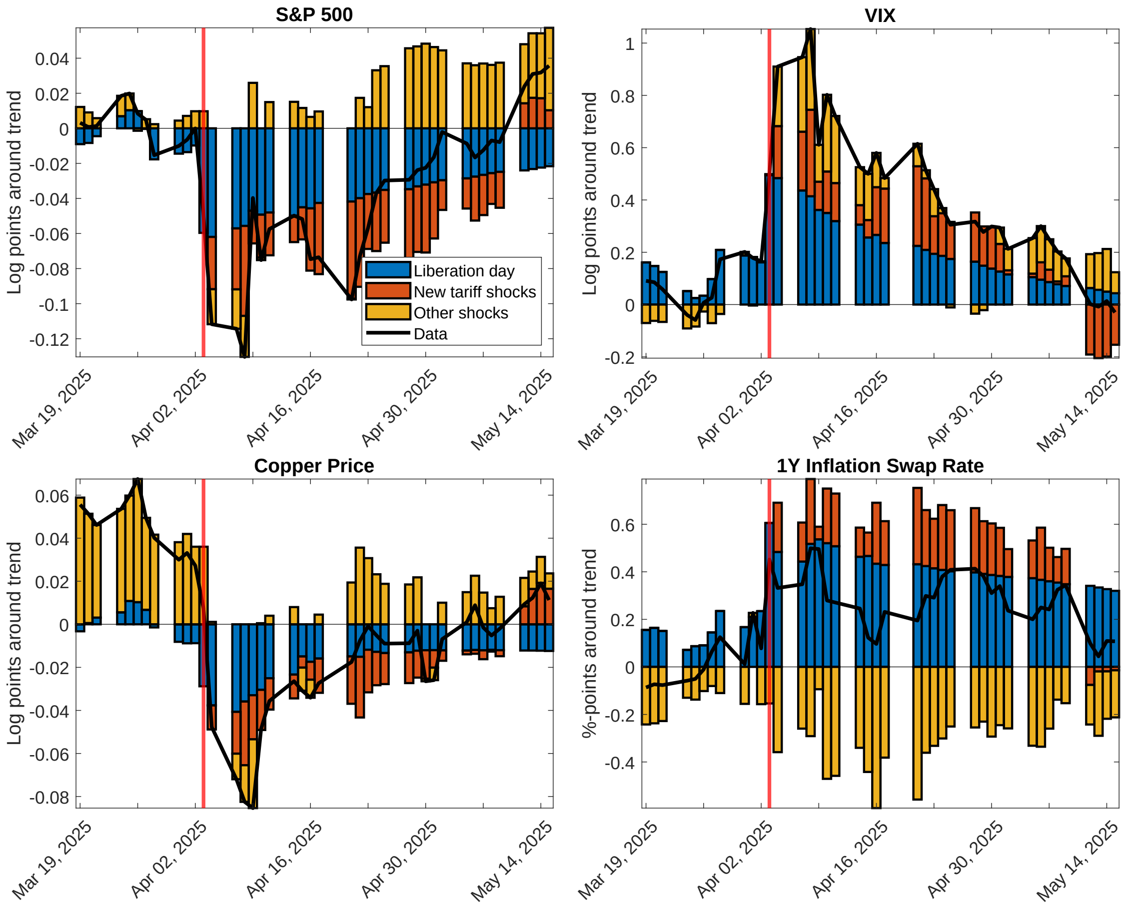
Figure 9: Historical decomposition: the U.S. dollar and the Treasury market



Notes: The figure presents historical decompositions of the VAR variables for the period 2025 Mar 19 – 2025 May 15. The blue bars represent the contribution of the tariff announcement shocks that were realised till 3 April 2025. The red bars represent the contribution of new tariff announcement shocks that realised after 3 Apr 2025. The yellow bars represent the contribution of all other orthogonalised shocks in the VAR. The black lines show the detrended data (using the deterministic component of the VAR for detrending, i.e. $\boldsymbol{d_t}$ in 2.3). By the nature of the orthogonalisation method, the change in the data from 2 April (marked by the red vertical line) to 3 April is driven solely by changes in the blue bars.

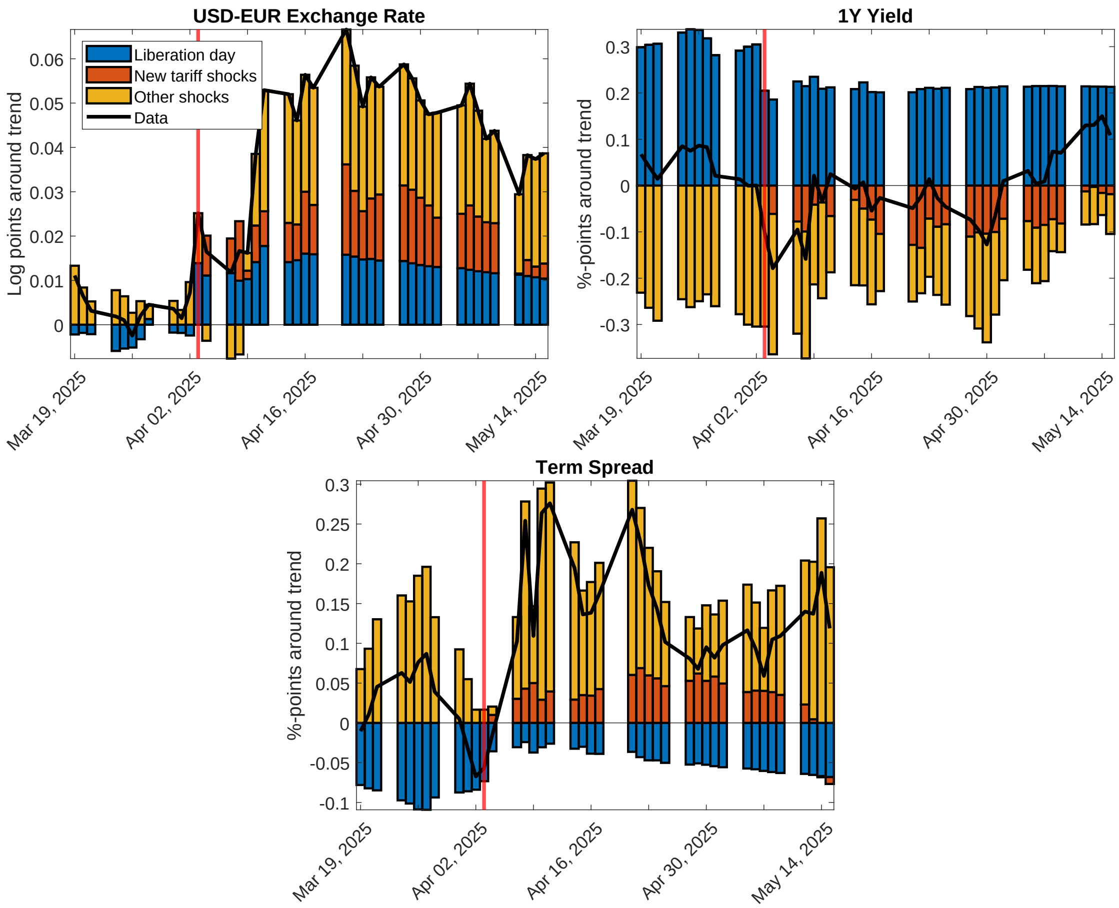
A.3.3 Historical Decompositions from a VAR(10)

Figure 10: Historical decomposition: stock market, copper prices and inflation expectations



Notes: The figure presents historical decompositions of the VAR variables for the period 2025 Mar 19 – 2025 May 15. The blue bars represent the contribution of the tariff announcement shocks that were realised till 3 April 2025. The red bars represent the contribution of new tariff announcement shocks that realised after 3 Apr 2025. The yellow bars represent the contribution of all other orthogonalised shocks in the VAR. The black lines show the detrended data (using the deterministic component of the VAR for detrending, i.e. $\boldsymbol{d_t}$ in 2.3). By the nature of the orthogonalisation method, the change in the data from 2 April (marked by the red vertical line) to 3 April is driven solely by changes in the blue bars.

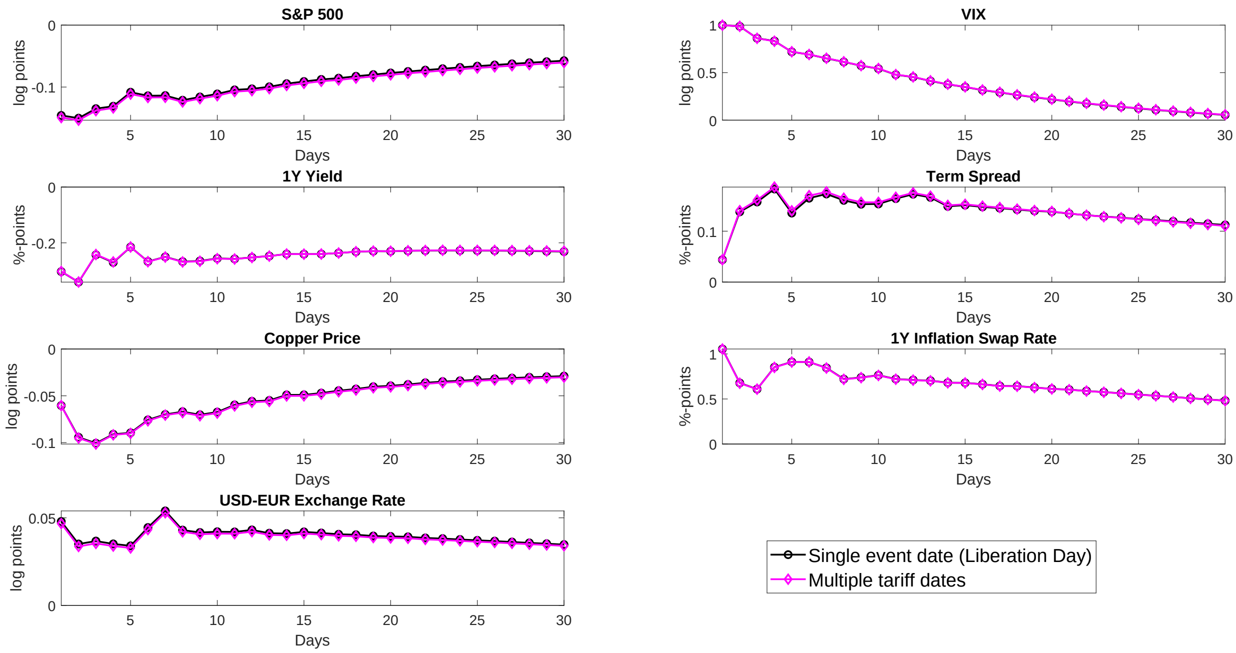
Figure 11: Historical decomposition: the U.S. dollar and the Treasury market



Notes: The figure presents historical decompositions of the VAR variables for the period 2025 Mar 19 – 2025 May 15. The blue bars represent the contribution of the tariff announcement shocks that were realised till 3 April 2025. The red bars represent the contribution of new tariff announcement shocks that realised after 3 Apr 2025. The yellow bars represent the contribution of all other orthogonalised shocks in the VAR. The black lines show the detrended data (using the deterministic component of the VAR for detrending, i.e. $\boldsymbol{d_t}$ in 2.3). By the nature of the orthogonalisation method, the change in the data from 2 April (marked by the red vertical line) to 3 April is driven solely by changes in the blue bars.

A.4 Orthogonalisation Based on Multiple Event Windows

Figure 12: Orthogonalisation based on Liberation Day vs multiple event windows



Notes: The black circled lines depict impulse response functions for our baseline tariff announcement shock. The magenta diamond lines depict the impulse response functions for the case when the orthogonalisation is based on explaining three event windows (3.1). Both sets of impulse response functions are normalised to increase the VIX by one log points.

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