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Abstract

We estimate the macroeconomic effects of U.S. tariff shocks in a Bayesian VAR identified via a narrative-dominance approach. In a sample starting in 1990, we find that tariff shocks: (i) reduce real activity, (ii) lower CPI inflation in the short run and raise it in the medium run, (iii) *depreciate* the U.S. dollar effective exchange rate, (iv) induce an S-shaped improvement of the trade balance, and (v) prompt an expansionary response of monetary policy. We show that the exchange-rate response depends on the degree of *structural* trade policy uncertainty (S-TPU), i.e., uncertainty about the persistence of the underlying trade-policy regime. We estimate S-TPU from a state-space stochastic-volatility model of tariff rates. When S-TPU is low, tariffs raise economic activity and inflation, and appreciate the exchange rate, in line with the textbook prediction. When S-TPU is high, the same shock depreciates the exchange rate, depresses economic activity, and elicits a more accommodative monetary policy response. We rationalize these findings in a model with incomplete international financial markets and uncertainty about the persistence of tariff policy. When uncertainty is sufficiently high, agents partially perceive transitory tariffs as persistent and borrow against expected future trade surpluses, leading to a depreciation of the exchange rate.

Keywords: tariff, exchange rate, structural trade policy uncertainty.

JEL Classification Numbers: E31, D83.

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1 Introduction

The resurgence of protectionist trade policies in the United States has reignited interest in the macroeconomic effects of tariffs. Despite the salience of the issue, the empirical literature on the dynamic effects of tariff shocks remains surprisingly limited. Empirical contributions by Schmitt-Grohé and Uribe (2025), den Besten, Barnichon, Känzig, and Singh (2026), and Franconi and Hack (2025), employing alternative identification schemes, are important recent exceptions. In parallel, a rapidly growing theoretical literature has developed to analyze the macroeconomic effects of tariffs through the lens of modern dynamic general-equilibrium models, distinct from the more traditional international-trade literature based predominantly on partial-equilibrium analysis.[1]

Against this background, this paper makes *four* contributions, to both strands of the literature, organized around a single empirical puzzle: the effect of tariffs on the exchange rate.

Tariff shock identification First, and in the spirit of Antolín-Díaz and Rubio-Ramírez (2018), we propose a narrative-dominance strategy for the identification of tariff shocks in a Bayesian VAR (BVAR) on U.S. quarterly data from 1990 to 2025. The approach combines a sign restriction on real imports with historical-decomposition restrictions imposed at a small set of well-documented narrative tariff episodes. At each anchor date, the identified tariff shock is required to be the dominant contributor to the realized movement in the U.S. import tariff rate. Our approach ties identification at historical dates of unambiguous policy origin without taking a stance on the sign of the response of any variable other than real imports - in particular, it leaves the sign of the exchange-rate response to be estimated in the data. We find that positive tariff shocks are contractionary on real economic activity, deflationary in the short run and inflationary in the medium term, generate a S-shaped response of the trade balance (an improvement at first, followed by a deterioration), induce an expansionary response by monetary policy, and - most strikingly - produce a persistent nominal and real *depreciation* of the U.S.-dollar effective exchange rate. The latter result is in stark contrast to the conventional textbook prediction of exchange rate appreciation, typically working via expenditure-switching from foreign currency (imported goods) towards the domestic currency (domestically produced goods).

We then extend the analysis to study the transmission of U.S. tariff shocks to the Euro area. To this end, we estimate a quarterly BVAR that combines Euro area

[1] We discuss the existing empirical and theoretical literature in a dedicated section below.

variables with the U.S. block and identify tariff shocks using the same narrative-dominance strategy. Since the baseline U.S. tariff dates do not coincide with any major Euro area retaliation, the shocks can be interpreted as plausibly external to the Euro area economy. We find that U.S. tariff shocks transmit abroad primarily as adverse demand shocks: Euro area activity contracts, HICP inflation falls at short horizons, and monetary policy initially turns more accommodative.

Structural trade-policy uncertainty Our second contribution is to show that the effects of tariffs on the exchange rate, as well as other key macroeconomic variables, depend on the underlying degree of *structural* trade policy uncertainty (S-TPU). Conceptually, what matters for agents' forward-looking decisions is not only the tariff rate in force today, but also the uncertainty about the *persistence* of the underlying trade-policy stance, which is unobserved. We decompose the observed tariff measure into two components: (i) a persistent component, modelled as a near-unit-root AR(1) process, and (ii) a transitory tariff disturbance. We define S-TPU as the conditional variance of the structural innovations to the persistent component of tariff policy. We construct an empirical measure of S-TPU estimating a state-space stochastic-volatility model. Our S-TPU index is the resulting filtered series of the structural volatility state. Notably it is conceptually distinct from the aggregate tariff volatility TPU index estimated in the univariate approach by Caldara et al. (2020). The aggregate TPU index pools two components, that we separately estimate: announcement-driven transitory uncertainty and uncertainty about the persistent trade-policy regime. S-TPU isolates the latter and differs from the aggregate index in its timing: it rises around episodes of genuine regime change - e.g., the 2017 U.S. withdrawal from the Trans-Pacific Partnership and the USMCA ratification - while remaining relatively muted around tariff threats and announcements that, ex post, leave the trade-policy regime unaltered.

State-dependent transmission Our third contribution is to document that, in U.S. data, the empirical response of the exchange rate to an import tariff shock is *state-dependent*. Using S-TPU as a conditioning variable in state-dependent local projections, we find that the conventional textbook implications - a nominal and real appreciation of the exchange rate, a tightening of monetary policy, an expansion in economic activity and a rise in inflation - prevail in states of *low* S-TPU. In states of *high* S-TPU, by contrast, the same tariff shock generates an exchange rate depreciation, an accommodative monetary-policy response, a contraction in both economic activity and inflation. Notably, conditioning on the aggregate TPU index of Caldara et al. (2020) eliminates the asymmetry, suggesting that it is structural, not noise-driven, trade policy uncertainty that governs the macroeconomic transmission of tariff shocks.

Exchange rate under S-TPU Finally, we build a small open-economy incomplete-markets New Keynesian model that rationalizes the above evidence. Two ingredients are central to our setup. First, the tariff in place at each date is the sum of a persistent stance, evolving as a near-unit-root AR(1) process, and a transitory *i.i.d.* disturbance. Agents observe the realized tariff but not its decomposition: from the history of observed tariffs, they form a Kalman-filtered estimate of the persistent stance, with a steady-state Kalman gain that is monotonically increasing in S-TPU. High S-TPU induces agents to attribute a larger share of any tariff surprise to a durable regime shift. Second, financial markets are incomplete: households trade one-period bonds subject to a portfolio-adjustment cost. In this context, as in a large class of models with segmented financial markets (Gabaix and Maggiori (2015), Fanelli and Straub (2021), Schmitt-Grohé and Uribe (2003)), the standard uncovered interest parity condition is modified to include a financial premium that depends on the country's net foreign asset position. The current real exchange rate therefore responds to the *expected path* of future trade balances.

In the modified UIP condition, the exchange rate is driven by two channels: (i) the conventional interest-rate differential and (ii) the financial premium, which is proportional to the present value of future trade balances. We label the latter as the *persistence channel* of the exchange rate. Under certainty, a purely temporary tariff shock does not activate the persistence channel, so that the current real exchange rate depends only on a conventional real interest rate differential. Under trade policy uncertainty, however, even a transitory tariff shock generates, on impact, a Bayesian update that lifts the agents' estimate of the persistent stance by a fraction equal to the Kalman gain. The revision is read as a forecast of higher future tariffs and, in turn, as a forecast of higher future trade balances. Under incomplete markets, the intertemporal external-balance condition requires the household to *borrow today* against expected future trade surpluses, deteriorating the net foreign asset position. The expected cumulated NFA path is in turn priced into the current real exchange rate through the modified UIP relation, generating an exchange-rate *depreciation* whose strength is governed by the *perceived* persistence of the shock. The impact response of the real exchange rate is therefore the sum of (i) a static expenditure-switching effect that pushes toward appreciation, and (ii) a forward-looking persistence effect that pushes toward depreciation. S-TPU governs the relative weight of the two forces: above a certain threshold, the persistence channel dominates and the exchange rate depreciates on impact.

Under complete information, a transitory tariff shock produces a strictly temporary one-period real exchange rate appreciation. Under moderate and high S-TPU, the impact response of the real exchange rate changes sign and the depreciation persists for several quarters, tracking the empirical pattern documented in the state-dependent local projections. Trade-policy uncertainty therefore acts not merely as an amplifier of the exchange-rate response to tariffs, but as a force that can change its sign.

Literature review Our paper speaks to two complementary strands of the literature on the macroeconomic effects of tariffs. The first is an *empirical* literature that uses time-series methods to estimate the dynamic effects of tariff shocks. Boer and Rieth (2024) provide one of the first SVAR-based assessments for the United States, combining sign and narrative restrictions and emphasizing that tariff shocks raise trade-policy uncertainty in addition to inflation. Franconi and Hack (2025) construct a quarterly-weighted import-tariff series and document the systematic response of U.S. monetary policy to tariff shocks. Schmitt-Grohé and Uribe (2025), in a latent state-space framework, separate transitory and permanent tariff shocks and show that the two carry sharply different implications for inflation, output, and the external accounts. den Besten, Barnichon, Känzig, and Singh (2026) construct a long-run narrative instrument for plausibly exogenous U.S. tariff changes, exploiting major legislative actions from 1840 to 2024. Their evidence shows that tariff increases are systematically contractionary, with sharp declines in imports and delayed declines in exports. Garimella et al. (2025) provide complementary event-study evidence from the April 2025 tariff announcement, showing that asset prices embedded a persistent deterioration in expected profits and an abnormal depreciation of the U.S. dollar against safe-haven currencies. Corsetti et al. (2025) estimate local projections of the U.S. dollar exchange rate on effective U.S. tariff shocks, allowing the response to differ with foreign retaliation. They find that unilateral tariff shocks appreciate the dollar, whereas retaliated tariff actions weaken it. Our contribution to this strand of the literature is twofold. First, we propose a narrative-dominance identification scheme on quarterly frequency data. Second, we document that tariff shocks generate a persistent depreciation of the U.S. dollar effective exchange rate, and that this response is state-dependent in the underlying degree of structural trade-policy uncertainty.

The second is a fast-growing *theoretical* literature that interprets the macroeconomic effects of tariffs through dynamic general-equilibrium models. Earlier contributions

- Barattieri et al. (2021), Auray et al. (2022, 2025), Bergin and Corsetti (2023), and Erceg et al. (2023) - analyze tariffs in New Keynesian open-economy environments, emphasizing, respectively, firm entry, strategic and self-enforcing trade policy, optimal monetary stabilization, and equivalence to fiscal-devaluation. The renewed protectionist stance of the United States has triggered a second wave of contributions, emphasizing especially the interaction between tariff policy and monetary policy: Boer and Rieth (2024), Jeanne and Son (2024), Kalemli-Özcan et al. (2025), Monacelli (2026), Bianchi and Coulibaly (2025), Cuba-Borda et al. (2025), Auclert et al. (2025), Itskhoki and Mukhin (2025), Costinot and Werning (2025), and Werning et al. (2025).

Closest to our analysis is Kalemli-Özcan et al. (2026), who also study how tariff uncertainty can overturn the textbook prediction of currency appreciation, motivated by the 2025 "Liberation Day" dollar-depreciation episode. In their two-country model with CARA households and risk-sensitive intermediaries operating in segmented financial markets, an increase in tariff volatility raises precautionary savings and generates a positive risk-premium wedge in the UIP condition, producing contemporaneous home-currency depreciation even as tariff levels rise. Our framework complements Kalemli-Özcan et al. (2026): rather than working through the conditional variance of the exchange rate, we emphasize a Bayesian-learning channel in which structural uncertainty about the *persistence* of the tariff regime leads agents to misperceive transitory tariffs as persistent, and - via incomplete international financial markets - to borrow against expected future trade surpluses. The ensuing deterioration of the current account, in turn, is a force that pushes towards a depreciation of the exchange rate.

The remainder of the paper is organized as follows. Section 2 describes the data and presents the narrative-dominance VAR evidence. Section 3 introduces the distinction between announcement-driven and structural trade-policy uncertainty, constructs the S-TPU index, and documents the state-dependent transmission of tariff shocks. Section 4 develops the equilibrium model, characterises the persistence channel analytically, and reports the quantitative simulations. Section 5 concludes.

2 Tariff Shocks in a Narrative Bayesian VAR

In this section we specify the tariffs and exchange rate data employed in the analysis and present our empirical methodology.

Tariff data Our baseline measure of trade policy is the Weighted Import Tariff rate, *WIT1*. Following Franconi and Hack (2025), we measure U.S. import tariffs as customs duties collected relative to the value of *dutiable* imports. This construction delivers a trade-weighted tariff rate and therefore gives limited weight to tariff changes applied on small trade flows. Compared with the alternative measures discussed below, WIT1 has a narrower scope but a more transparent interpretation.

Alternative tariff measures: WIT2 and TRI We also consider two alternative trade-policy measures used in the literature and compiled by Schmitt-Grohé and Uribe (2025). The first is an alternative Weighted Import Tariff rate, *WIT2*, defined as customs duties collected relative to the value of *total* goods imports, including duty-free imports. The second is the Trade Restrictiveness Index, *TRI*, a welfare-based tariff measure first introduced by Anderson and Neary (1994). The TRI can be interpreted as the uniform tariff rate that, in a given period, delivers the same level of welfare as the observed tariff schedule. Importantly, the TRI increases not only with the average level of tariffs, but also with their cross-sectional dispersion. It therefore captures the welfare costs associated with the uneven allocation of tariffs across goods. Figure 1 shows that both alternative measures, WIT2 and TRI, are highly correlated with our benchmark WIT1 over the sample period.[2]

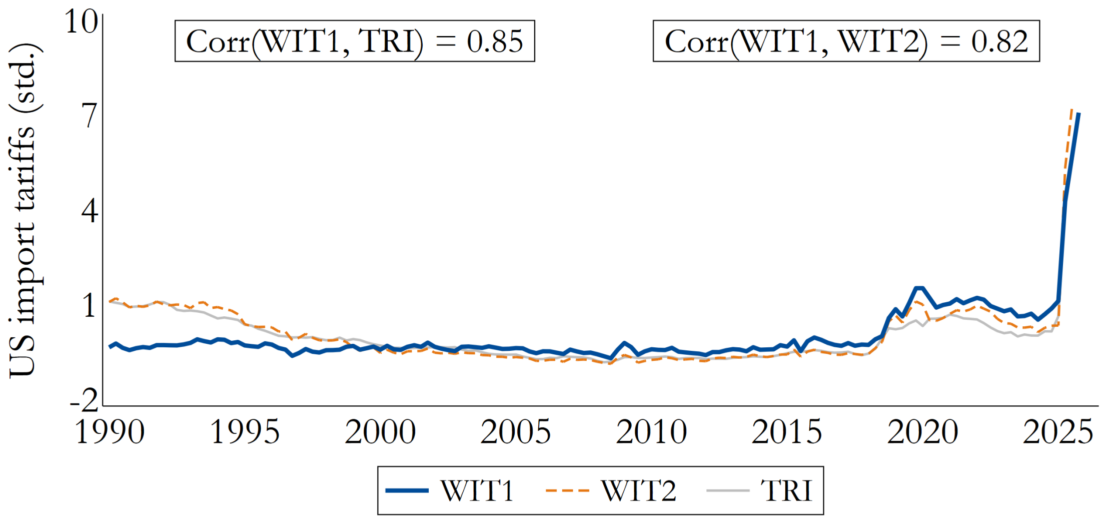
We restrict our analysis to a sample beginning in 1990Q1 for two main reasons. First, our preferred tariff index, WIT1, is available only starting in 1990. Second, the post-1990 period provides a more homogeneous trade-policy regime. This period coincides with the consolidation of the modern multilateral trading system—the GATT-to-WTO transition (1995) and the subsequent integration of China and other large emerging economies into world trade—and thus captures a phase of broadly stable and deepening global trade integration.

Exchange rate data Our baseline exchange-rate measure is the U.S. nominal effective exchange rate (*NEER*). The *NEER* is constructed as a trade-weighted average of bilateral exchange rates against 26 U.S. trading partners. The weights vary over time and capture both direct trade with each partner and competition with that partner in third markets. An increase in the index denotes a U.S. dollar appreciation.

As an alternative to the NEER, we consider the U.S. Dollar Index (*DXY*), a fixed-weight index of the dollar against six major currencies. Unlike the NEER, which is a trade-weighted measure based on a broad and time-varying set of trading

[2]We also replicate the empirical exercises below using the WIT2 and the TRI as the tariff measure. The results are qualitatively unchanged and are available upon request.

Figure 1: U.S. import tariff: WIT1, WIT2, and TRI



Notes: Three alternative measures of U.S. import tariffs: the two weighted-import measures (WIT1, blue; WIT2, orange) and the Trade Restrictiveness Index (TRI, grey). The series are expressed in standard deviations, from 1990Q1 to 2025Q2.

partners, the DXY is a fixed-basket financial benchmark, heavily tilted toward the euro.[3] We also consider and present the results for the U.S. real effective exchange rate (*REER*), also from the BIS, which adjusts the nominal effective exchange rate for relative price movements across trading partners. For more details on all the data series adopted, see Online Appendix B.1.

2.1 BVAR Specification

We estimate a Bayesian VAR on a sample of key U.S. macroeconomic variables at quarterly frequency from 1990Q1 to 2025Q2 and use it to identify the macroeconomic effects of import tariff shocks. We adopt the main tariff measure introduced above - the weighted import tariff (WIT1) - and report results on the nominal and real exchange rates in the main text.

Let y_t denote an $n \times 1$ vector of endogenous variables with $n = 10$, ordered as

$$y_t = \begin{bmatrix} \text{Inv}_t & \text{X}_t & \text{M}_t & \text{TB}_t & \text{GDP}_t & \text{CPI}_t & \text{Unc}_t & \text{Ex. Rate}_t & \tau_t & i_t \end{bmatrix}'$$

where Inv_t is real private investment, X_t is real exports, M_t is real imports, TB_t is

[3] Online Appendix B.1 provides further details on the construction of the exchange-rate series. We also replicate all empirical exercises using the DXY as the exchange-rate measure. The results are qualitatively unchanged and are available upon request.

the trade balance as a share of nominal output, GDP_t is real output, CPI_t is CPI inflation, Unc_t is the Jurado et al. macroeconomic uncertainty index, Ex. Rate_t is the nominal (real) effective exchange rate, τ_t (WIT1) is the weighted import tariff and i_t is the federal funds rate. All variables enter in levels, except for real private investment, real exports, real imports, real output, and the effective exchange rate, which enter in logs.

The reduced-form VAR(p) model is:

$$y_t = c + \sum_{j=1}^{p} A_j y_{t-j} + u_t, \qquad t = 1, \dots, T \tag{1}$$

where c is an $n \times 1$ vector of intercepts, A_j are $n \times n$ coefficient matrices, and $u_t \sim \mathcal{N}(0, \Sigma_u)$ is the $n \times 1$ vector of reduced-form innovations with symmetric positive-definite covariance Σ_u. The benchmark specification includes a deterministic intercept and $p = 4$ lags of the ten endogenous variables.

2.2 Narrative Identification of Tariff Shocks

We identify tariff shocks by exploiting a small set of historical episodes in which movements in U.S. tariffs can be traced, based on public news and policy documents, to discrete trade-policy actions. These episodes provide narrative anchors for the structural tariff shock. Our approach follows the narrative restriction framework of Antolín-Díaz and Rubio-Ramírez (2018), specialized to a single tariff shock, and is closely related to De Santis and Van der Veken (2026), who identify financial and uncertainty shocks using narrative restrictions while remaining agnostic about the impact matrix and the dynamic responses. In our setting, the narrative information disciplines the sign and timing of the tariff shock, while leaving the rest of the structural system unrestricted.

Narrative dominance restrictions Let $u_t = B\,\varepsilon_t$ be the structural decomposition of the reduced-form BVAR model in (1), where $u_t \sim \mathcal{N}(0, \Sigma_u)$ and $\varepsilon_t \sim \mathcal{N}(0, I_n)$. The structural impact matrix is constructed as $B = \text{chol}(\Sigma_u)\,Q$, with Q a randomly drawn orthogonal matrix, following Rubio-Ramírez et al. (2010). The k-th column of B is the structural impact vector associated with the innovation $\varepsilon_{k,t}$: it maps that scalar innovation into the reduced-form forecast errors u_t. Narrative restrictions therefore select which column of B, if any, is labelled as the tariff shock ε_t^{τ}; the remaining columns are not assigned an economic label. The unexpected change in variable i at date t (i.e., the one-step-ahead forecast error) admits the shock-by-shock decomposition:

$$\underbrace{y_{i,t} - \mathbb{E}_{t-1} y_{i,t}}_{u_{i,t}:\ \text{one-step-ahead forecast error}} = e_i' B \varepsilon_t = \underbrace{\sum_{j=1}^{n} b_{ij}\, \varepsilon_{j,t}}_{\text{shock-by-shock decomposition}} \tag{2}$$

where b_{ij} is the (i, j) element of B and e_i the i-th unit vector.

A *narrative dominance* restriction imposes, at a chosen date t^*, that the structural tariff shock ε^τ is the largest contributor to the forecast error of the tariff rate τ_t among shocks whose contribution pushes that forecast error in the *same direction*. Let C_{τ,t^*} denote the contribution of the candidate tariff shock to the forecast error of τ_t at t^* (cumulated over t^* and the preceding quarter) and $C^{(k)}_{\tau,t^*}$ the analogous contribution of the k-th non-tariff shock. The restriction requires:

$$|C_{\tau,t^*}| > \max \left\{ |C^{(k)}_{\tau,t^*}| \ : \ \text{sign}(C^{(k)}_{\tau,t^*}) = \text{sign}(C_{\tau,t^*}) \right\} \tag{3}$$

Following De Santis and Van der Veken (2026), notice that the above restriction is strictly weaker than the original Antolín-Díaz and Rubio-Ramírez (2018) requirement that ε^τ dominate *all* other shocks, $|C_{\tau,t^*}| > \max_k |C^{(k)}_{\tau,t^*}|$: an unrestricted shock may contribute more as long as it moves the tariff in the opposite direction. The flexibility matters here, because tariff changes are routinely accompanied by offsetting forces - exchange-rate movements, retaliation, monetary policy - that attenuate the observed change in the effective tariff. The set of anchor dates $\mathcal{T}^* = \{t_1^*, \ldots, t_K^*\}$ is chosen according to the criteria of narrative and statistical relevance, as outlined in Section 2.3 below.[4]

Three features of this identification strategy are worth emphasizing. First, the object of the restriction is the *forecast error* of the tariff rate, not its level, at t^*. Identification is therefore obtained from the unanticipated component of each narrative episode. Second, the identifying variation is pinned down by narrative, plausibly exogenous tariff movements directly tied to observable trade-policy actions. Third, the strategy is deliberately agnostic about the responses of the variables whose sign is theoretically disputed. Besides the auxiliary sign restriction on real imports, we do not restrict the responses of trade balance, output, inflation, or monetary policy. In particular, the sign of the exchange-rate response is left to be estimated from the data.

[4]The dominance restriction is imposed at the baseline horizon $h = 1$ and, as a robustness check, at $h = 3$.

Sign restriction on real imports The dominance restriction (3) fixes the source of the tariff-index forecast error at t^* but is silent about the sign of the shock and its transmission. We therefore add a supplemental restriction on the impulse response of real imports. Let M_t denote log real goods imports and IRF_h^m the response of M_t to a unit positive tariff shock at horizon h. The standard demand effect implies that an import-tariff increase should reduce imported quantities, as higher tariff-inclusive import prices induce substitution away from foreign goods. Formally, we impose the restriction:

$$\mathrm{IRF}_h^m \ < \ 0 \qquad \text{for } h \in \{1, 2\} \tag{4}$$

where we deliberately leave the impact response *unrestricted*.[5] This choice is motivated by recent U.S. tariff evidence of a pronounced *front-loading* pattern: upon announcement, importers accelerate shipments to clear customs at the pre-hike rate, generating a transitory positive spike in volumes in the quarter the tariff takes effect (Fajgelbaum et al., 2020; Amiti et al., 2019).[6] Restricting the sign only at $h = 1, 2$ preserves the demand effect at the horizon at which front-loading has unwound, while remaining agnostic about the impact response.

Estimation Following Uhlig (2005); Rubio-Ramírez et al. (2010); Arias et al. (2018), we estimate the reduced-form VAR in (1) under a flat conjugate prior on $(A_1, \ldots, A_p, c, \Sigma_u)$. This yields the standard conjugate Normal–Inverse–Wishart posterior, centered at the OLS estimates and treating Σ_u as unknown. We then simulate from this posterior by rejection sampling. At each iteration, we draw a reduced-form parameter vector and retain it only if the implied VAR is stable,[7] and this ensures that impulse responses are well defined and converge after a shock. For each stable reduced-form draw, we sample candidate orthogonal rotations Q of the impact matrix B described above. A structural draw is accepted if one candidate column satisfies the narrative dominance restriction (3) and the import sign restriction (4). This column is labelled the tariff shock, ε^τ, while the remaining shocks are left unidentified. The procedure is repeated until 1,000 structural draws are retained, allowing up to 100 candidate rotations for each stable reduced-form draw. For each accepted draw, we compute impulse responses and the historical decomposition of τ_t. Impulse responses are reported over 15 quarters as posterior medians

[5] This means that we do *not* impose $\mathrm{IRF}_h^m < 0$ from $h = 0$.

[6] U.S. imports from China rose sharply in 2018Q3, just ahead of the September 24 implementation of § 301 List 3, before falling back through 2019; a similar acceleration is visible in U.S. goods imports in 2025Q1 ahead of the April reciprocal tariffs.

[7] Specifically, we write (1) in companion form, $Y_t = C + FY_{t-1} + U_t$, where $Y_t = (y_t', y_{t-1}', \ldots, y_{t-p+1}')'$ and F collects the autoregressive coefficients $(A_1, \ldots, A_p)$. A reduced-form draw is kept only if all eigenvalues of F have modulus below one.

with 68% and 90% credible bands, normalized so that the impact response of the weighted import tariff equals one percentage point.

2.3 Selection of Narrative Dates

We select the dates $\mathcal{T}^*$ on the basis of three jointly applied criteria:

(C1) *Narrative clarity.* t^* must correspond to a clearly identified, publicly announced change in U.S. tariff policy, attributable to a specific instrument (executive order, USTR[8] determination, presidential proclamation, or statutory action).

(C2) *Sizeable movement in* τ_t*.* The change in the weighted tariff rate at t^* must be too large to be plausibly generated by composition effects, business-cycle feedback, or measurement noise. Formally, the standardized quarterly change $z(\Delta\tau_{t^*})$ must exceed unity in absolute value.

(C3) *Sign consistency.* The empirical sign of $\Delta\tau_{t^*}$ must be consistent with the direction of the announced policy change in (C1).

Notice that criterion (C2) ensures that restriction (3) is informative at t^*: when the realized forecast error of τ_t is small the restriction is non-binding. Criterion (C3) rules out dates at which a clear announcement coincides with an offsetting movement driven by other sources.

Applying (C1)-(C3) to the 1990Q1-2025Q2 sample yields the baseline date set in Panel A of Table 1: the *2018Q4* imposition of the Section 301 List 3 tariffs and the *2025Q2* "Liberation Day" package. The same analysis criteria deliver the extended set for robustness (Panel B) that adds *2019Q3* (List 4A) and *2019Q4* (Airbus counter-measures and List 4A continuation).
Figure 2 plots the quarter-on-quarter *changes* of three tariff measures - the TRI, the WIT1, and the WIT2 - together with the four narrative dates isolated above. All three series register sizable jumps at each of the narrative dates, indicating that the episodes we identify are large in magnitude regardless of how the aggregate tariff is measured.

Narrative evidence by event More details on each individual narrative event and its salience is reported in the Online Appendix B.2.

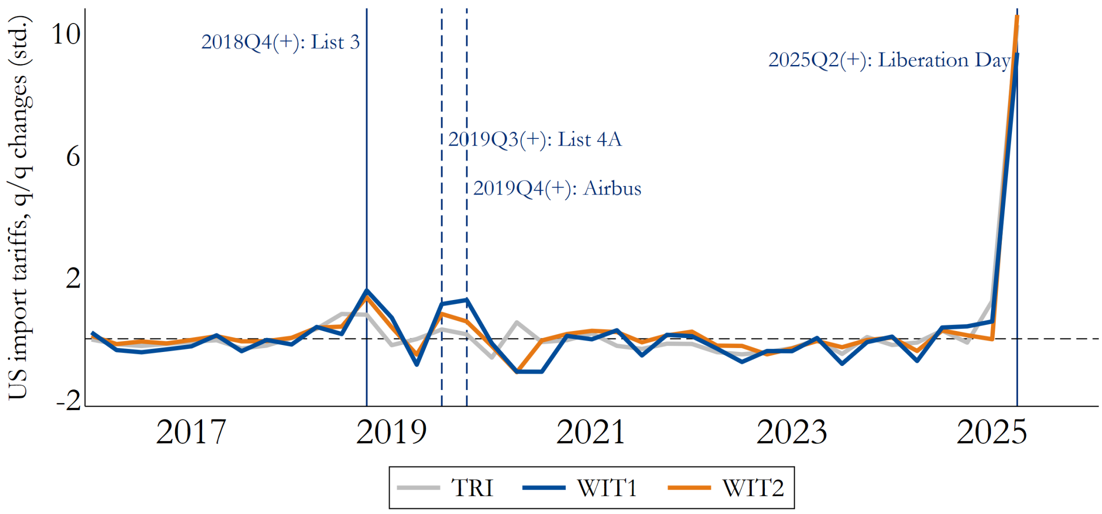
[8] USTR is acronym for Office of the United States Trade Representative.

Table 1: Narrative dates for tariff shock identification

Date	$z(\Delta\tau)$ (std.)	Narrative event
Panel A: Baseline		
2018Q4	+1.83	§ 301 List 3, $200B at 10% (Sept. 24, 2018)
2025Q2	+10.6	"Liberation Day" reciprocal tariffs (Apr. 2, 2025)
Panel B: Extended		
2019Q3	+1.33	§ 301 List 4A, $112B at 15% (Sept. 1, 2019)
2019Q4	+1.48	WTO-Airbus countermeasures (Oct. 18, 2019) and § 301 List 4A continuation

Notes: The Table reports: (i) the narrative dates for tariff shock identification, (ii) $z(\Delta\tau)$: the corresponding standardized quarterly change in WIT1, and (iii) a brief description of the narrative event. Dates are selected on criteria (C1)-(C3). Panel A is the baseline set of dates for the main results; Panel B is the extended set used in the robustness in Online Appendix B.3.

Figure 2: Standardized quarter-on-quarter changes in U.S. import tariffs



Notes: Three alternative measures of U.S. import tariffs: the two weighted-import measures (WIT1, blue; WIT2, orange) and the Trade Restrictiveness Index (TRI, grey). Each series is standardized by its sample mean and standard deviation. Vertical lines mark narrative events.

2.4 Results from BVAR

We estimate the effects of the identified shocks to the weighted import tariff index WIT1, within the Bayesian VAR.[9] Figure 3 plots the response of the U.S. nominal effective exchange rate (NEER) and of a selected set of macroeconomic variables to a one-percentage-point weighted import-tariff shock, estimated over the sample 1990Q1-2025Q2, together with the corresponding 68% and 90% posterior credible bands. The exchange-rate index is normalized so that a decrease corresponds to a *depreciation* of the U.S. dollar. Figure 4 reports the same impulse responses estimated on a *shorter sample* starting in 2002Q1, while Figure 5 displays the response of the real effective exchange rate (REER) over the two samples.

Following a one-percentage-point increase in the weighted import tariff, both the NEER and the REER gradually depreciate and remain persistently below their pre-shock levels over the medium term, exhibiting a pattern consistent with the delayed-overshooting evidence of Eichenbaum and Evans (1995) for monetary shocks. The observed depreciation runs counter to the textbook prediction that higher import tariffs should induce an exchange-rate appreciation through an expenditure-switching channel, whether on currencies or goods.

A positive tariff shock is contractionary. Real GDP declines and remains below baseline for several quarters before gradually recovering. The contraction is initially more pronounced for real private investment, which displays a persistent decline. Inflation follows an S-shaped pattern, falling moderately over the first few quarters and rising significantly thereafter. Following the initial decline in real activity and inflation, monetary policy responds by lowering the nominal interest rate. The short-run pattern suggests that the tariff shock operates primarily through an aggregate-demand channel, and the increase in macroeconomic uncertainty reinforces this interpretation. On the external balance side, both exports and imports contract, consistent with weaker demand and lower trade flows. The trade-balance-to-GDP ratio follows an S-shaped pattern: it initially improves for a few quarters, and deteriorates over the medium horizon. The S-shaped pattern of the trade balance ratio is especially clear in the short sample estimate of Figure 4, where also the effect on the real exchange rate is more tightly estimated.

Robustness on event dates Our baseline identification anchors the tariff shock on two large, unanticipated tariff actions in 2018Q4 and in 2025Q2, reported in panel A of Table 1. We assess whether the results depend on this event set by

[9] Results based on the alternative tariff measures, WIT2 and the TRI index, are broadly in line with those obtained under WIT1, and are available upon request.

re-estimating the BVAR with the *extended* narrative set in Online Appendix B.3. This set adds the 2019Q3 Section 301 List 4A and the 2019Q4 WTO-Airbus tariffs, which are more modest or goods-specific shocks documented in panel B of Table 1. The estimated responses of the exchange rate and other macroeconomic variables are essentially unchanged.

Summary of empirical findings We briefly summarize our empirical findings on the U.S. economy. Based on a narrative-dominance identification approach, positive tariff shocks generate (i) a persistent depreciation of both the nominal and the real U.S. dollar effective exchange rate, (ii) a contraction in real GDP and investment, (iii) an S-shaped response of inflation, (iv) an accommodative monetary-policy reaction, (v) a rise in macroeconomic uncertainty, and (vi) an initial improvement of the trade-balance ratio followed by a deterioration. We now turn to an analysis of the effects of U.S. tariff shocks on the Euro area.

2.5 International BVAR

Next we examine the effects of U.S. tariff shocks on the Euro area economy. We estimate a new quarterly Bayesian VAR over the sample 1990Q1-2025Q2, combining Euro area variables and U.S. macro variables.[10] We identify the BVAR with the narrative approach outlined above, using the baseline tariff events selected of Table 1. The reduced-form VAR has the same structure as in equation (1). Let y_t denote the $n \times 1$ vector:

$$y_t = \Big[\text{GDP}_t \quad \text{CPI}_t \quad \text{Ex. Rate}_t \quad \text{TB}_t \quad \text{Unc}_t \quad i_t \quad \text{GDP}^{EA}_t \quad \text{HICP}^{EA}_t \quad i^{EA}_t \quad \tau_t \quad \text{M}_t\Big]'$$

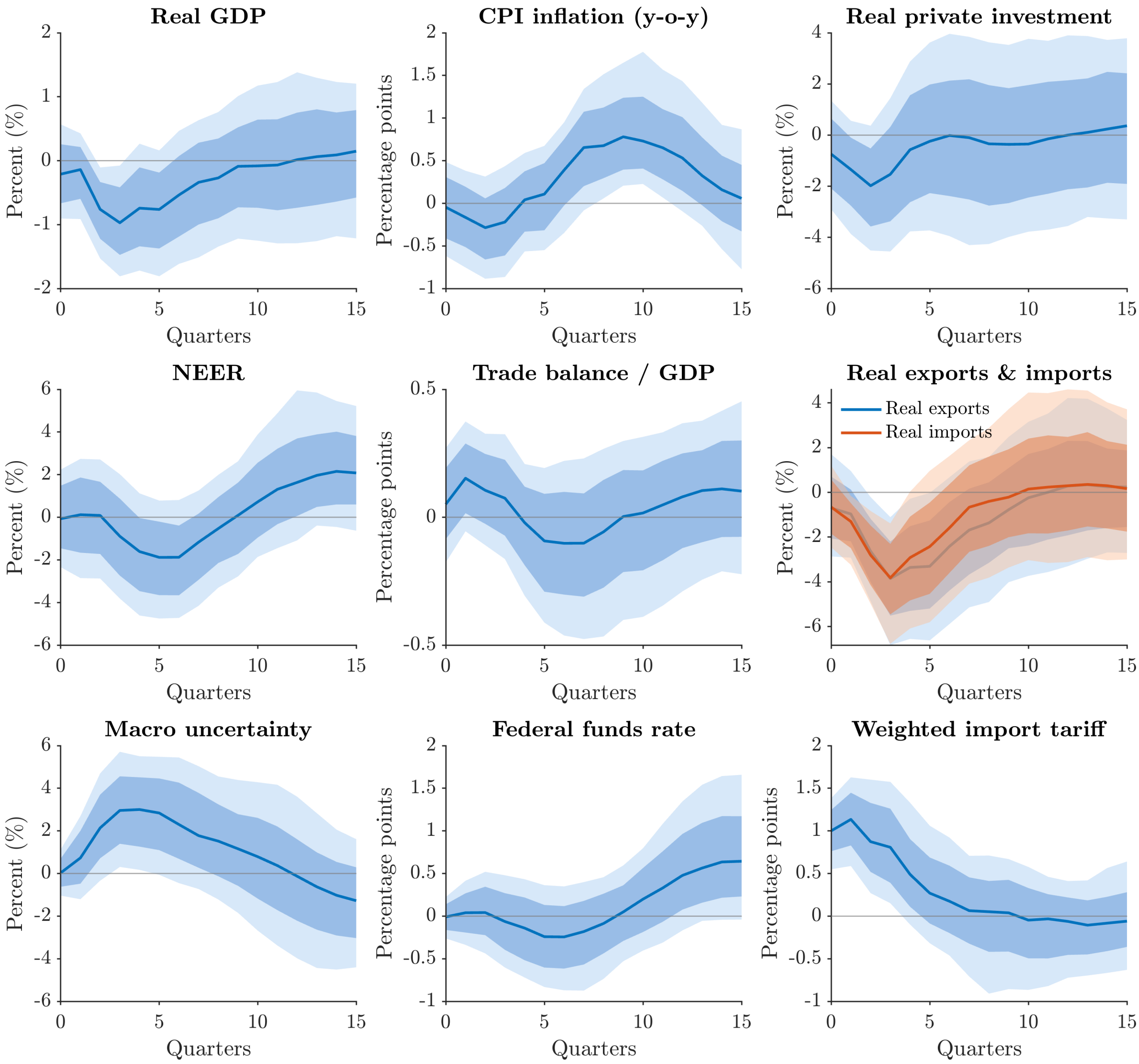
Figure 6 reports the impulse responses of the Euro area real GDP, HICP inflation, and the 3-month EURIBOR rate to a 1 percentage point U.S. weighted-import tariff shock. A potential concern in the international BVAR is that the narrative U.S. tariff dates capture contemporaneous Euro area retaliation. We rule this out by reviewing Euro area trade-policy sources - European Commission/DG Trade releases, EUR-Lex, WTO records, and major newspapers - and none of the baseline U.S. tariff events satisfying C1-C3 coincides with EU retaliation.[11] Hence, in the

[10] All U.S. variables keep the notation used in the benchmark specification; Euro area variables are denoted with an EA superscript, i_t^{EA} is the 3-month EURIBOR rate.

[11] We also audit EU tariff actions around the *extended* set of U.S. tariff dates. In response to the 2019Q4 U.S. Airbus tariff shock, the EU imposed WTO-authorized countermeasures on U.S. aircraft and selected agricultural and industrial products, with rates of 15 percent and 25 percent, respectively. These measures were goods-specific and only lasted from 2020Q4 to 2021Q1 (European Commission, 2020, 2021). In 2025Q2, the EU prepared, but did not enact, countermeasures

baseline specification, the narrative-identified U.S. tariff shocks can be treated as plausibly external to the Euro area economy.

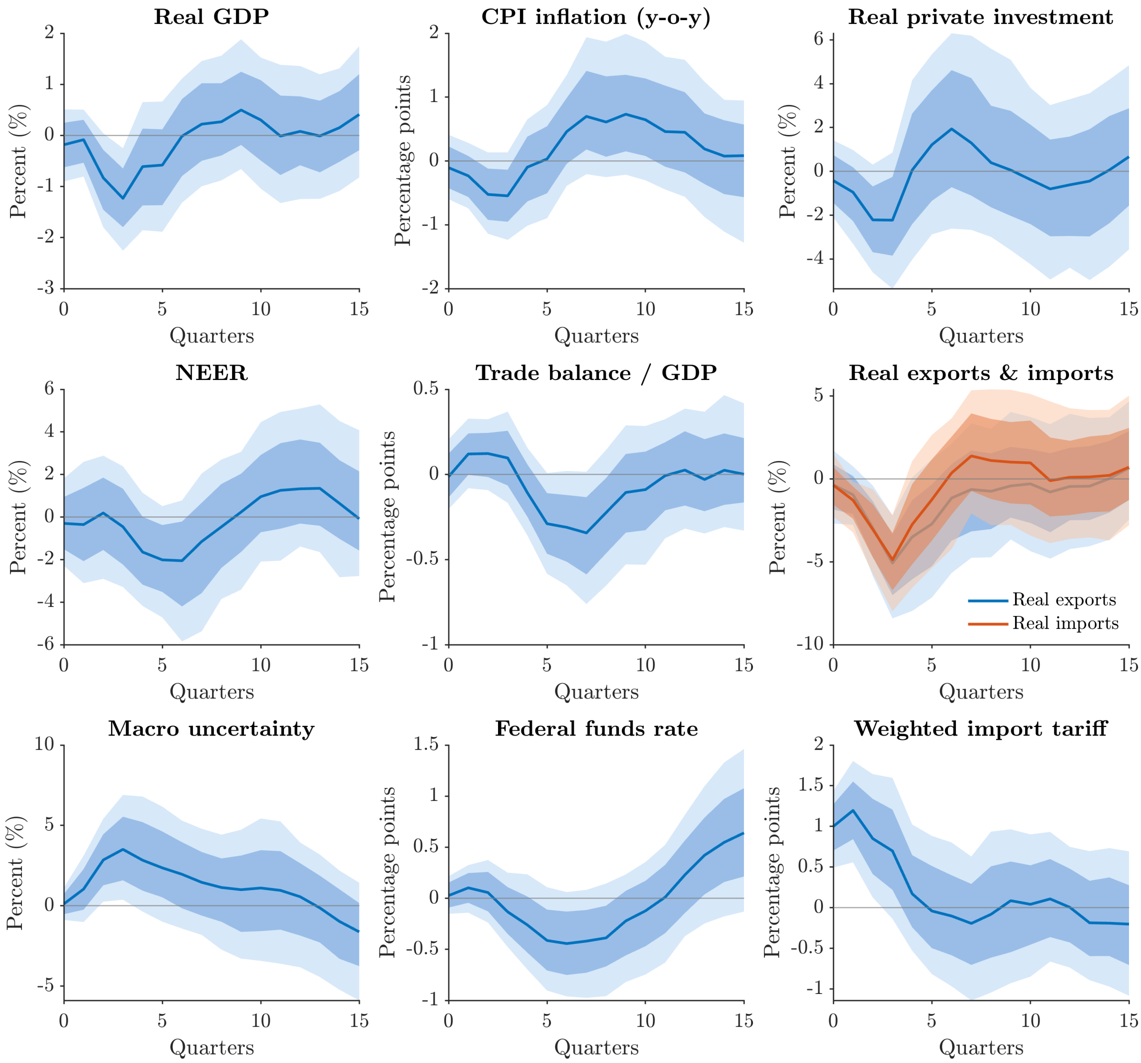
Figure 3: Estimated impulse responses of NEER and other macroeconomic variables to a 1 p.p. weighted-import tariff shock. A fall in the exchange rate is a depreciation



Notes: Impulse responses of real GDP, CPI inflation, real private investment, the nominal effective exchange rate (NEER), the nominal trade balance-to-GDP ratio, real exports, real imports, the Macroeconomic Uncertainty index from Jurado et al. (2015) and the Federal funds rate to a 1 p.p. shock to the weighted import tariff, estimated in the BVAR in Section 2.1. The sample covers U.S. quarterly data from 1990Q1 to 2025Q2. The blue line represents the posterior median, and the shaded areas are 68% and 90% credible sets.

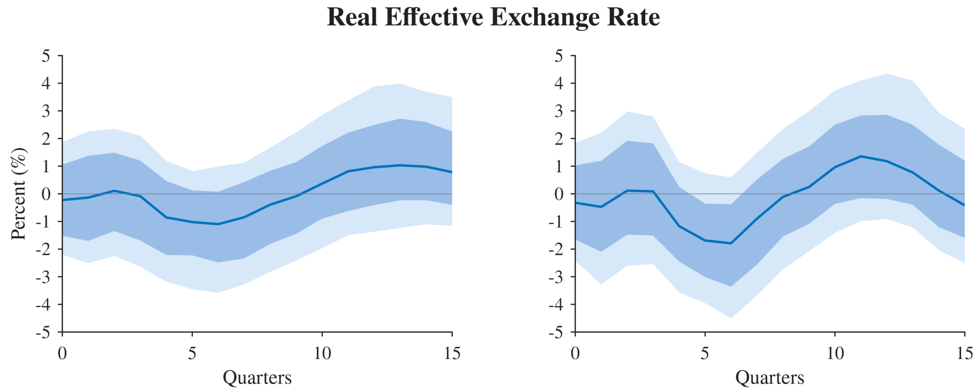
in response to "Liberation Day" (European Commission, 2025).

Figure 4: *Shorter sample*. Estimated impulse responses of NEER and other macroeconomic variables to a 1 p.p. weighted-import tariff shock. A fall in the exchange rate is a depreciation



Notes: Same impulse responses as Figure 3, estimated on U.S. quarterly data from 2002Q1 to 2025Q2.

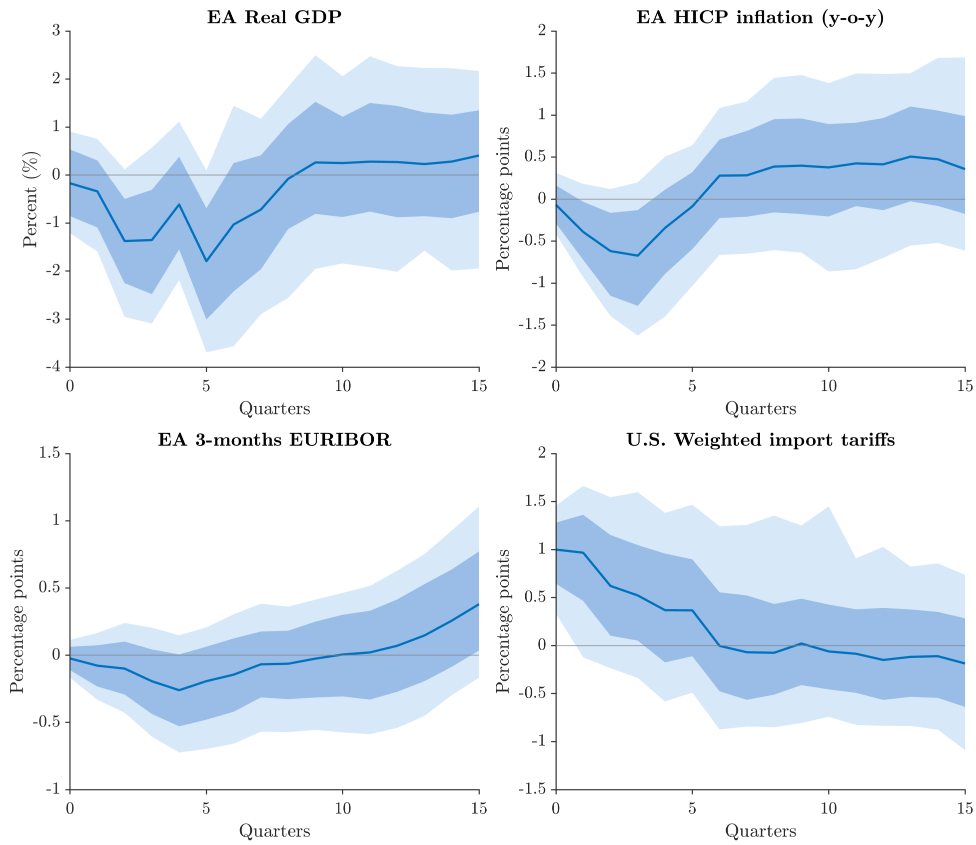
Figure 5: Estimated impulse responses of the REER to a 1 p.p. shock to the weighted-import tariff. A fall in the exchange rate is a depreciation



(a) 1990–2025 (b) 2002–2025

Notes: Impulse response of the real effective exchange rate (REER) to a 1 p.p. shock to the weighted import tariff estimated in the BVAR in Section 2.1. Panel (a) reports results for the 1990Q1-2025Q2 sample, while panel (b) reports results for the 2002Q1-2025Q2 sample.

Figure 6: Estimated impulse responses of EA Real GDP, EA HICP, and EA 3-month EURIBOR to a 1 p.p. shock to the U.S. weighted-import tariff



Notes: Impulse responses of Euro area variables (real GDP, HICP inflation, EA 3-month EURIBOR) to a 1 p.p. U.S. weighted-import tariff shock. Responses are obtained in the BVAR specified in Section 2.5 For further details, see the note to Figure 3.

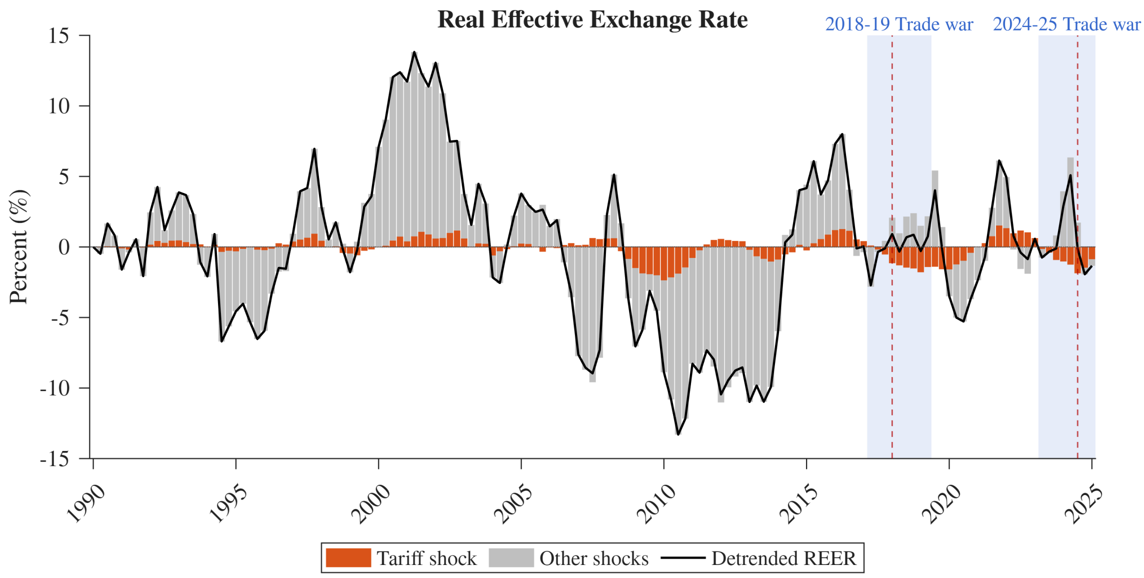
Results from the international BVAR Figure 6 reports the Euro area responses to a U.S. import tariff shock. The shock generates (i) a contraction in Euro area real GDP, concentrated in the first year after the shock, (ii) a short-run decline in HICP inflation followed by a medium-run mild increase, and (iii) an initially accommodative EURIBOR response that reverses as inflationary pressures materialize. The evidence therefore suggests that U.S. tariff shocks transmit to the Euro area as adverse external-demand shocks, lowering activity and inflation at short horizons.

2.6 How relevant are tariff shocks for the business cycle?

To assess the quantitative relevance of tariff shocks in driving the REER dynamics, we compute the historical decomposition from the narrative BVAR. The raw REER series is the linear combination of many structural shocks, and the decomposition isolates the contribution of the tariff shocks from all others. Figure 7 displays this decomposition for the REER. The contribution of the tariff component (in orange) grows markedly in the later part of the sample, reflecting two major tariff episodes in the last decade (both shaded): the 2018-19 trade war under the first Trump administration and the 2025 escalation under Trump II. Notably, the REER overall appreciates during the first episode while it depreciates during the second. Yet in *both* periods the estimated tariff contribution points toward a real *depreciation.* This implies that during the 2018-19 trade war, shocks other than tariffs must have driven the overall real appreciation of the U.S. dollar. Quantitatively, the tariff component accounts for no more than 4 percent of the REER decomposition before 2015, but rises to as much as 11 percent after 2016.

What is the contribution of tariff shocks to the business cycle evolution of key macroeconomic variables? Table 2 reports the forecast-error variance decomposition (FEVD) - respectively at quarter 1, 5, 10, and 15 - of the REER, real GDP, CPI inflation and trade-balance ratio. Overall, tariff shocks estimated by our methodology explain a non-trivial share of the FEVD of all variables, ranging from 3.5 to 15.5 percent for the REER, from 4.2 to 14.2 percent for real GDP, from 3.8 to 20 percent for CPI inflation and from 3.9 to 13.2 for the trade-balance ratio.

Figure 7: Historical decomposition of the REER



Notes: The black solid line is the detrended U.S. real effective exchange rate (REER) and the orange bars show the historical contribution of tariff shocks. Vertical dotted red lines mark the baseline narrative dates. Shaded areas highlight the trade wars in 2018-19 and 2025. A fall in the exchange rate is a depreciation.

Table 2: FEVD: Share Explained by the Tariff Shock

	Forecast horizon (quarters)			
	1	5	10	15
REER	3.5	6.4	11.0	15.5
	[0.4, 13.8]	[2.3, 14.6]	[4.6, 22.6]	[7.1, 27.5]
Real GDP	4.2	6.0	12.7	14.2
	[0.4, 16.0]	[2.0, 15.1]	[3.9, 29.7]	[6.0, 27.4]
CPI Inflation	3.8	7.3	16.7	20.1
	[0.3, 15.9]	[2.6, 16.5]	[6.5, 30.0]	[9.4, 32.7]
Trade Balance / GDP	3.9	11.2	12.3	13.2
	[0.3, 15.9]	[4.1, 27.3]	[5.2, 23.7]	[6.3, 24.5]

Notes: Entries report the posterior median share of the forecast error variance (in percent) accounted for by the tariff shock. 68% credible intervals in brackets.

3 Which Trade-Policy Uncertainty?

In this section we show that our previous results hold conditional on the underlying degree of trade policy *uncertainty*. Conceptually, the transmission of a tariff shock to the economy should depend on what agents infer about the trade policy behind it. Two beliefs are central. The first concerns the tariff *level* in force today: how credibly the announced rate will be enforced and how fully it will be collected at the border. We label this as *transitory* trade-policy uncertainty. The second type of uncertainty concerns the *persistence* of the trade-policy regime in place: whether it will be quickly reversed or consolidated into a lasting policy framework. Existing trade-policy uncertainty indexes - such as Caldara et al. (2020) and Baker et al. (2016) tend to conflate the two types of uncertainty. Below we develop a taxonomy of trade-policy uncertainty and show how each type of uncertainty shapes the transmission of tariff shocks through different channels.

3.1 Transitory TPU

The first source of uncertainty concerns the current tariff rate level. We refer to this as *transitory* TPU because - contrary to uncertainty about trade-policy persistence - it vanishes when tariffs are paid. We present two illustrative cases of transitory TPU about the level of tariff duties.

Tariff noise The first example of transitory TPU occurs before a policy is implemented, when agents observe announcements, threats, or proposals, but these signals need not coincide with the tariff rate eventually enacted. For example, a presidential threat of a 100 percent tariff may contain information about the direction of policy, but it is an imprecise signal of the rate that will ultimately become legally binding. This type of uncertainty is announcement *noise* and it is typically resolved at implementation, when the statutory tariff schedule becomes known.

Statutory vs actual tariffs The second example of transitory TPU occurs when a tariff is formally enacted, and the statutory rate may differ from the actual rate effectively collected at the border. Gopinath and Neiman (2026) document this *statutory-actual* tariff gap and report that, by September 2025, the trade-weighted statutory rate stood at 27.4 percent, while the actual collected rate was only 14.1 percent. This wedge reflects shipping lags, exemptions, USMCA compliance, and enforcement gaps.[12] Unlike announcement noise, this component of transitory TPU

[12] USMCA refers to the United States-Mexico-Canada Agreement, which replaced NAFTA on 1 July 2020.

is not resolved immediately at implementation. It is gradually revealed over time as customs receipts accumulate.

3.2 Structural TPU

The second type of tariff policy uncertainty concerns the *persistence* of tariff measures. Whether a tariff is temporary or durable depends on the country's trade-policy regime. By trade-policy regime, we mean the policy rule or regime that governs the introduction, maintenance, and reversal of tariff measures. The regime pins down tariff persistence: a tariff is persistent when it reflects a durable reorientation of trade-policy, and temporary when it serves a transitory policy objective, such as bargaining leverage in trade negotiations or geoeconomic objectives. Uncertainty about the trade-policy regime therefore translates directly into uncertainty about tariff persistence. When the trade-policy regime is stable, tariff actions are tied to clear policy objectives, making their persistence easier to infer. In a more discretionary environment, the same tariff action is harder to interpret because both its policy objective and expected duration are less clear. We refer to uncertainty about the underlying trade-policy regime as *structural* trade-policy uncertainty, or *S-TPU*.

A clean illustration of an increase in S-TPU is the U.S. withdrawal from the Trans-Pacific Partnership (TPP) in January 2017. The episode did *not* change applied tariff rates on impact. Hence, it did not create transitory trade-policy uncertainty about the tariff level. Instead, the TPP withdrawal raised uncertainty about the future orientation of U.S. trade policy. By weakening rules-based multilateral commitments, it made future tariff actions harder to link to clear policy objectives, casting uncertainty about tariff persistence.

We conjecture that S-TPU is central to the transmission of tariff shocks. In the theoretical model presented later, uncertainty about tariff persistence fundamentally changes the propagation of tariff shocks, with first-order implications for the exchange rate and other key variables. For this reason, the remainder of the paper focuses on this second form of trade-policy uncertainty. The next section proposes a methodology to measure S-TPU in the data.

3.2.1 Constructing an S-TPU index

We propose a measure of *structural* trade-policy uncertainty (S-TPU). The measure builds on the single-factor tariff stochastic-volatility framework of Caldara et al. (2020), but separates uncertainty about the *persistent* trade-policy regime from volatility in *transitory* tariff disturbances. Differently from Caldara et al. (2020) who use one latent volatility process for tariff innovations, we allow observed tariffs to reflect both a persistent and a transitory component, each with separate stochastic volatility. S-TPU is defined as the conditional variance of the innovations to the persistent component. As such, S-TPU captures uncertainty about changes in the underlying trade-policy regime rather than transitory tariff fluctuations.

State-space representation of tariffs We model the effective tariff rate, denoted by τ_t, in state-space form. The tariff rate is observed, while its persistent and transitory components, together with their innovation volatilities, are latent states. The measurement equation reads:

$$\tau_t = \tau_{S,t} + \tau_{T,t},$$

where $\tau_{S,t}$ denotes the persistent tariff regime and $\tau_{T,t}$ denotes a transitory tariff noise component. The persistent component evolves as:

$$\tau_{S,t} = \rho_S \cdot \tau_{S,t-1} + \exp(\sigma_{S,t})\varepsilon_{S,t}, \qquad \varepsilon_{S,t} \sim \mathcal{N}(0,1),$$

while the transitory component follows:

$$\tau_{T,t} = \rho_T \cdot \tau_{T,t-1} + \exp(\sigma_{T,t})\varepsilon_{T,t}, \qquad \varepsilon_{T,t} \sim \mathcal{N}(0,1).$$

Innovations $\varepsilon_{S,t}$ shift the underlying trade-policy regime and therefore affect expected future tariffs. Innovations $\varepsilon_{T,t}$ instead capture tariff movements assigned to the transitory component. The two components have separate stochastic-volatility processes:

$$\sigma_{j,t} = (1-\rho_{\sigma j})\bar{\sigma}_j + \rho_{\sigma j}\sigma_{j,t-1} + \eta_j u_{j,t}, \qquad u_{j,t} \sim \mathcal{N}(0,1), \qquad j \in \{S,T\}$$

All innovations are mutually independent. The state $\sigma_{S,t}$ governs the conditional variance of shocks to the persistent trade-policy regime, while $\sigma_{T,t}$ governs the conditional variance of transitory tariff shocks. Empirically, we estimate the latent objects by filtering the observed tariff path. Conditional on the calibrated parameters, the S-TPU index is the filtered estimate of the conditional variance of innovations to the persistent trade-policy component:

$$STPU_t \equiv \exp(2\sigma_{S,t})$$

Model calibration and filtering We calibrate the state-space stochastic-volatility model to distinguish between a slow-moving, stable trade-policy stance and short-lived, more volatile tariff noise. Conditional on the calibrated parameter vector, we apply the particle filter of Born and Pfeifer (2014) to the standardized U.S. effective tariff rate.[13] The filter delivers estimates of the latent persistent trade-policy stance, $\tau_{S,t}$, and of the log-volatilities of structural and transitory tariff innovations, $\sigma_{S,t}$ and $\sigma_{T,t}$. We report full details on the calibration and filtering procedures in Online Appendix B.4.

Structural versus aggregate TPU Figure 8 compares our S-TPU index, estimated from the stochastic-volatility state-space model, with the newspaper-based index of aggregate trade-policy uncertainty, TPU, from Caldara et al. (2020). The TPU index measures the salience of trade-policy uncertainty in major outlets, counting articles containing at least one trade-policy term near at least one uncertainty term.[14] Before 2017 high-S-TPU episodes are short-lived, and both series remain relatively subdued. A major break occurs in the 2017-2020 trade-war period. As major trade-policy events raised uncertainty about the durability of the existing U.S. trade-policy regime, S-TPU rises sharply, reaching about six standard deviations above its historical mean. The U.S. withdrawal from the Trans-Pacific Partnership (TPP) and the renegotiation of the North American Free Trade Agreement (NAFTA) into the United States-Mexico-Canada Agreement (USMCA) called into question the previous rules-based liberalization framework and signaled a shift toward more discretionary bilateral bargaining. The aggregate TPU index also rises during this period, but much less persistently and by a smaller magnitude, with a peak of roughly two standard deviations.

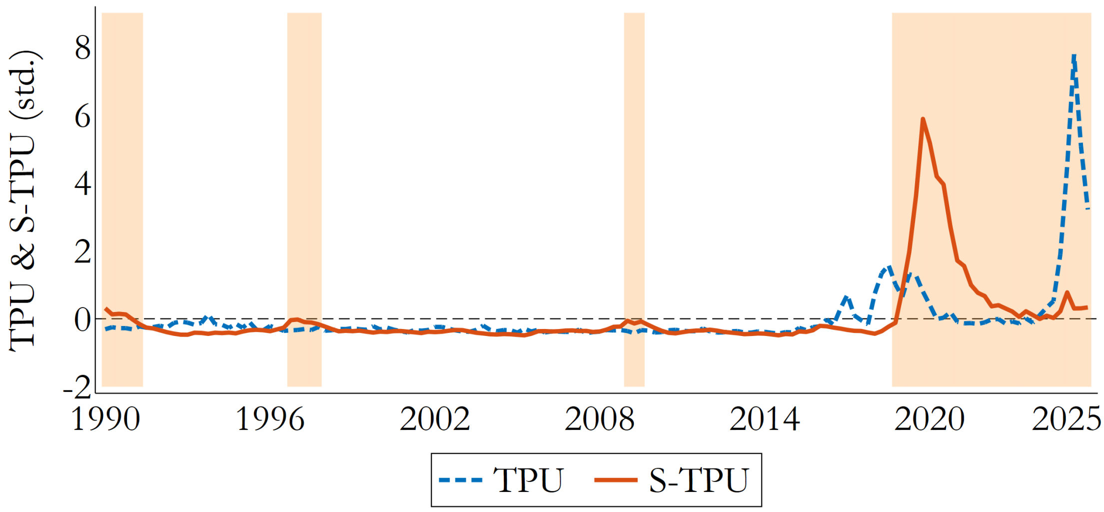
The contrast is reversed around the 2025 "Liberation Day" tariffs. Aggregate TPU spikes to an unprecedented level, about eight standard deviations above its historical mean, whereas S-TPU responds only modestly. In the model, this divergence indicates that the 2025 episode was dominated by transitory uncertainty about announcements, implementation, and near-term tariff levels, rather than by structural uncertainty about the persistent trade-policy regime that determines the expected future path of tariffs.

The shaded areas in Figure 8 mark quarters in the top 30 percent of the S-TPU

[13] Conditional on the calibrated parameter vector θ, the particle filter integrates over the latent tariff components and volatility states. It evaluates the marginal likelihood of the observed tariff path, $p(\tau_{1:T} \mid \theta) = \prod_{t=1}^{T} p(\tau_t \mid \tau_{1:t-1}, \theta)$, where each term is the one-step-ahead predictive density of the observed tariff rate.

[14] For the underlying dictionaries, see `https://www.matteoiacoviello.com/research_files/TPU_SUPP_MATERIAL.pdf`.

Figure 8: Aggregate TPU versus S-TPU index



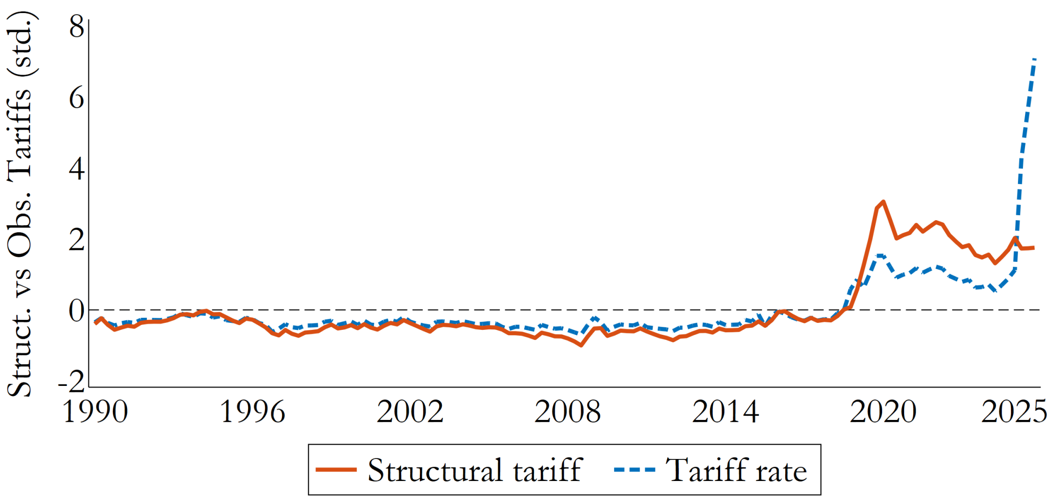
Notes: Quarterly newspaper-based TPU index of Caldara et al. (2020) (dotted) and estimated S-TPU index (solid). Shaded areas highlight observations in the top 30% of S-TPU. All series standardized.

distribution. These episodes cluster around moments when the future conduct of U.S. trade policy was plausibly being redefined. Importantly, they are not confined to the tariff-war episodes.The early-1990s block coincides with the transition toward a new multilateral order, marked by NAFTA entering into force in 1994 and by the 1993 conclusion of the Uruguay Round, which laid the basis for the creation of the WTO. The late-1990s block captures uncertainty about whether the United States would continue to lead the trade-liberalization agenda. A central episode was the failure to renew the fast-track trade negotiating authority in 1997-1998, which weakened the President's ability to conclude new trade agreements and raised doubts about the future path of U.S. tariffs and trade policy. The short 2009 block is different again. Against the backdrop of the global financial crisis, the block captures heightened uncertainty about existing or pending liberalization commitments, including the Korea-U.S. Free Trade Agreement (KORUS).

Structural versus observed tariff rate Figure 9 plots the observed tariff rate, τ_t (WIT1), together with the filtered structural tariff, $\tau_{S,t}$, recovered from the stochastic-volatility model. Until the mid-2010s, the two series move closely together. This comovement breaks down during the 2018–2020 trade-war episode. The structural component rises sharply in this period, as the United States revived Section 201, Section 232, and Section 301 authorities to impose new tariffs and renegotiated trade agreements. The tariff increases of that period are therefore filtered as a persistent shift in the level of U.S. trade policy, rather than as transitory tariff movements.

The two series diverge again toward the end of the sample. The observed tariff rate remains elevated after 2020 and rises sharply in 2025 "Liberation Day," whereas the structural tariff responds much less. The filter therefore maps only a limited part of the recent tariff surge to a further shift in the persistent trade-policy component.

Figure 9: Structural vs observed tariff rate



Notes: Quarterly evolution of the underlying structural tariff $\tau_{S,t}$ estimated in the data vs. WIT1 tariff rate τ_t. All series are standardized over the full sample.

3.3 State-Dependent Transmission of Tariff Shocks

We now use the S-TPU index to test the hypothesis that *Structural* TPU, and not the aggregate TPU index, governs the transmission of tariff shocks to the exchange rate and to other key macroeconomic variables. We run a set of local projections of the exchange rate - and other macroeconomic variables - in response to an identified tariff shock, for different states of the S-TPU index. S-TPU is therefore treated as an exogenous state of the economy that conditions the response to identified tariff shocks.[15]

S-TPU state-dependent local projections We consider the response of the exchange rate to a tariff shock for different states of the *Structural* TPU index. We

[15] State-dependent local projections identify the response to a large shock if the shock is exogenous and independent of the state (Gonçalves et al., 2024). Our narrative-identified tariff shocks are arguably exogenous to the state of Structural TPU.

follow the approach in Ramey and Zubairy (2018) and estimate state-dependent local projections (Jordà, 2005) of the exchange rate and other macroeconomic variables on narrative-identified tariff shocks extracted from the BVAR model.[16] Let H_t be an indicator variable that flags periods in which the estimated S-TPU index is in the high state. In the baseline specification, consider the *top* 30% of the distribution:[17]

$$H_t = \mathbf{1}\{STPU_t > p_{70}\}$$

We interact H_t with the series of exogenous weighted import tariff shocks $\{\varepsilon_t^\tau\}$ identified in the BVAR. As endogenous variables, we consider the nominal effective exchange rate (NEER), the real effective exchange rate (REER), the Federal funds rate, the trade-balance-to-GDP ratio, CPI inflation, and real GDP. The sample spans from 1990Q1 to 2025Q2. For each horizon $h = 0, \dots, 6$, and for each response variable y_t, we estimate

$$y_{t+h} = \alpha_h + \beta_h \varepsilon_t^\tau + \beta_h^H H_t \varepsilon_t^\tau + \delta_h H_t + \sum_{j=1}^{4} \gamma_{j,h} y_{t-j} + u_{t+h} \tag{5}$$

The term $\delta_h H_t$ is an *uncertainty-state control.* Additionally, β_h represents the response in the low-uncertainty regime ($H_t = 0$) and $\beta_h + \beta_h^H$ the response in the high-uncertainty regime ($H_t = 1$).

Results Figure 10 shows that the main variables of interest exhibit sharply different dynamics across low- and high-S-TPU regimes. In states of *low* S-TPU, namely in a transparent and predictable trade-policy environment, tariffs deliver their standard textbook implications: a nominal and real exchange-rate appreciation, a mild increase in CPI inflation and a tightening of monetary policy. Furthermore, under low S-TPU, real GDP increases mildly. By contrast, in states of *elevated* S-TPU,

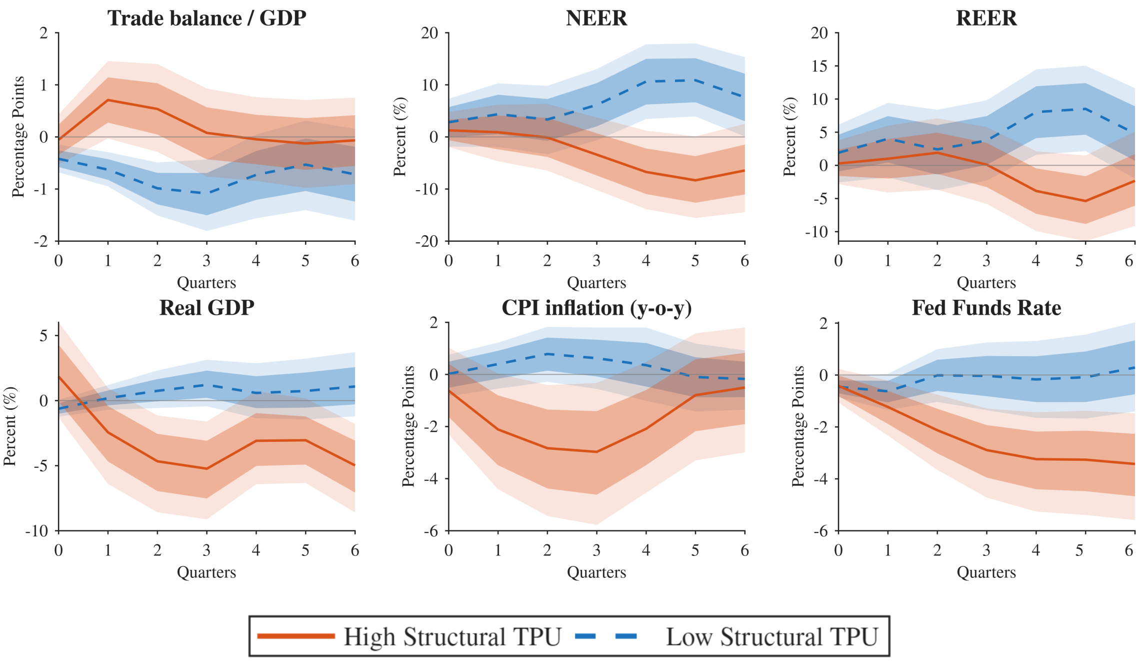
[16] The series of exogenous import tariff shocks is taken from a Bayesian VAR estimated at quarterly frequency over 1990Q1-2025Q2. The VAR includes four lags, a constant, and a flat conjugate prior. The system contains ten variables, ordered as follows: real private investment, real exports, real imports, the trade-balance-to-GDP ratio, real GDP, CPI inflation, macroeconomic uncertainty, the nominal effective exchange rate (NEER), the weighted-import tariff rate, and the Federal funds rate. The tariff shock is identified following Antolín-Díaz and Rubio-Ramírez (2018), combining historical-decomposition narrative-dominance restrictions with a sign restriction on imports. The narrative anchors are the *extended* dates discussed in Section B.2. The shocks are normalized to generate a one-percentage-point impact response of the weighted-import tariff rate. Results are robust to tariff shock series using baseline narrative dates and to excluding the constant from the VAR. For more information on the local projections, see Online Appendix B.5.

[17] In Online Appendix B.5.1, we replicate a set of state-dependent local projections with the "high S-TPU uncertainty state" identified as the top 40%, 20%, or top 10% of the S-TPU distribution. The results are qualitatively unchanged.

the same tariff shock generates both a nominal and real depreciation, a contraction in both GDP and inflation, and a more accommodative monetary policy response. Notice also that the response of the trade-balance ratio differs across regimes: the trade balance deteriorates in low S-TPU states whereas it improves under high S-TPU.

Notably, the asymmetry across S-TPU states is specific to S-TPU: conditioning on the aggregate TPU index, which mixes structural and transitory components, eliminates it.[18,19] This result is consistent with the view that S-TPU captures the dimension of trade-policy uncertainty that is relevant for firms' decisions, whereas the aggregate TPU index is contaminated by volatility from transitory or inconsequential tariff announcements.

Figure 10: Impulse responses of the exchange rate and other macroeconomic variables to an identified tariff shock across S-TPU states. A fall in the exchange rate is a depreciation



Notes: Impulse responses to an identified tariff shock under high (top 30% of the S-TPU distribution, solid orange) and low S-TPU state (bottom 70%, dashed blue). Shocks are normalized so that the median-shock local projection generates 1p.p. increase on impact in the trade-weighted tariff measure. The reported bands are 68% and 90% percentile bands of the pooled predictive distribution Hall-recentered. See Online Appendix B.5 for more details.

[18]For brevity, we only report the set of results based on the S-TPU index. All results based on the aggregate TPU index are available upon request.

[19]Corsetti et al. (2025) likewise document a state-dependent exchange-rate response to tariff shocks, conditioning on the presence or absence of retaliatory measures.

In the next section, we rationalize the S-TPU-based state-dependent pattern through a Bayesian framework in which agents observe the current tariff but must infer the persistence of the underlying trade-policy regime.

4 A Model of the Exchange Rate under Trade Policy Uncertainty

We highlighted that uncertainty on the persistence of the underlying tariff policy regime can significantly impact the response of the exchange rate and other macroeconomic variables to tariff shocks. We now study the implications of tariff policy uncertainty in a theoretical setup. We build a small open economy model with incomplete international financial markets, import tariffs, and a systematic conduct of monetary policy. The key element of our setup is that agents face *uncertainty* on the *persistence* of the underlying tariff policy regime. Households trade only one-period domestic and foreign-currency bonds, with foreign-bond holdings subject to a convex portfolio adjustment friction. Market incompleteness coupled with financial segmentation due to portfolio adjustment costs is a key ingredient of our framework: it breaks the standard uncovered interest parity (UIP) condition and activates a forward-looking exchange-rate channel that operates through the expected future path of net foreign assets. This channel is shown to be critical in driving the response of the exchange rate to tariff shocks.

4.1 Households

The representative household maximises

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right] \tag{6}$$

where C_t is a CES aggregate of Home and imported goods,

$$C_t = \left[(1-\nu)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \nu^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{7}$$

Here $\beta \in (0,1)$ is the discount factor, $\sigma > 0$ the inverse intertemporal elasticity of substitution, $\varphi > 0$ the inverse Frisch elasticity, $\eta > 0$ the trade elasticity of substitution between Home and imported goods, and $\nu \in (0,1)$ the steady-state import share.

Prices, tariffs, and the CPI Let $P_{H,t}$ denote the Home-currency price of the domestic good and $\mathcal{E}_t$ the nominal exchange rate, expressed as units of Home currency per unit of foreign currency.[20] We normalise the foreign-currency price of the imported good to 1, so that the Home-currency *border price* of imports is

$$P_{F,t} = \mathcal{E}_t$$

Imports are subject to an ad valorem tariff τ_t, which drives a wedge between the border price and the price faced by domestic consumers, $(1+\tau_t)P_{F,t}$. The utility-based CPI accordingly reads

$$P_t = \Big[(1-\nu)P_{H,t}^{1-\eta} + \nu\big((1+\tau_t)\mathcal{E}_t\big)^{1-\eta}\Big]^{\frac{1}{1-\eta}} \tag{8}$$

It is convenient to define the terms of trade and the CPI-PPI ratio as

$$S_t \equiv \frac{\mathcal{E}_t}{P_{H,t}}, \qquad \mathcal{G}_t \equiv \frac{P_t}{P_{H,t}} = \Big[(1-\nu) + \nu\big((1+\tau_t)S_t\big)^{1-\eta}\Big]^{\frac{1}{1-\eta}}$$

A rise in S_t amounts to a terms-of-trade deterioration: imported goods become more expensive relative to Home goods. Notice that $\mathcal{G}_t$ is increasing in both S_t and τ_t: both the exchange rate and the tariff feed into the CPI through the cost of imports relative to domestic prices.

Log-linearising (8) around a symmetric zero-tariff steady state delivers[21]

$$p_t = (1-\nu)\,p_{H,t} + \nu\,(e_t + \tau_t) \tag{9}$$

The CPI is thus a weighted average of the domestic price and the tariff-inclusive import price, with the tariff entering on the same footing as a rise in the Home-currency border price of imports.

Demand for Home and imported goods Cost minimisation by the household subject to (6)-(7) yields the standard CES demand system,

$$C_{H,t} = (1-\nu)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t = (1-\nu)\,\mathcal{G}_t^{\eta} C_t$$
$$C_{F,t} = \nu\left(\frac{(1+\tau_t)\mathcal{E}_t}{P_t}\right)^{-\eta} C_t = \nu\left(\frac{(1+\tau_t)S_t}{\mathcal{G}_t}\right)^{-\eta} C_t$$

[20] In the model notation, an increase in $\mathcal{E}_t$ corresponds to a depreciation of the Home currency.

[21] Lower-case variables denote log deviations from steady state, except b_t and tb_t, which denote the NFA position and the trade balance in absolute deviation from steady state, scaled by steady-state output. See below.

Around the symmetric zero-tariff steady state these conditions imply

$$c_{H,t} = c_t - \eta\,(p_{H,t} - p_t) \tag{10}$$

$$c_{F,t} = c_t - \eta\,(e_t + \tau_t - p_t) \tag{11}$$

A rise in the tariff τ_t, for given exchange rate and aggregate consumption, lowers the demand for imports and raises the demand for domestic goods, with an elasticity that is increasing in the trade elasticity η. This is the standard expenditure-switching channel; in general equilibrium, however, both c_t and e_t respond endogenously, and the final allocation depends on the conduct of monetary policy.

Budget constraint and bonds Households trade two one-period nominal bonds: a domestic bond B_t paying a gross return R_t in Home currency, and a foreign-currency bond B_t^* paying a gross return R_t^* in foreign currency. Denote the real market value of foreign-bond holdings, expressed in units of the Home CPI, by

$$\mathcal{B}_t \equiv \frac{\mathcal{E}_t B_t^*}{P_t}$$

The household's nominal budget constraint reads

$$P_t C_t + B_t + \mathcal{E}_t B_t^* + P_t\,\Psi(\mathcal{B}_t) \leq W_t N_t + \Pi_t + T_t + R_{t-1} B_{t-1} + R_{t-1}^* \mathcal{E}_t B_{t-1}^* \tag{12}$$

where W_t is the nominal wage, Π_t are firm profits rebated to the household, T_t is a lump-sum transfer from the government, and $\Psi(\mathcal{B}_t)$ is a portfolio adjustment cost specified below.

Tariff rebates Tariff revenue is rebated lump-sum to households,

$$T_t = \tau_t\,\mathcal{E}_t\,C_{F,t}$$

This rebate neutralises the pure income effect of tariff revenue in the aggregate; households nonetheless face the tariff-distorted relative price of imports at the margin, so the substitution channel of tariffs operates fully.

Financial segmentation Households face a strictly convex portfolio adjustment cost on their foreign bond holdings. We adopt the standard quadratic specification

$$\Psi(\mathcal{B}_t) = \frac{\psi}{2}\left(\frac{\mathcal{B}_t - \bar{\mathcal{B}}}{\bar{Y}}\right)^2, \qquad \Psi(0) = \Psi'(0) = 0, \quad \Psi''(0) = \psi > 0$$

with $\psi > 0$ governing the curvature of the cost function. We interpret ψ as a reduced-form representation of imperfect cross-border financial intermediation: when the Home economy needs to place a larger net foreign asset position on world markets, the exchange rate must move marginally more to induce private investors to absorb it. Thus, ψ governs the slope of the external financing schedule faced by the Home economy. This interpretation is in the spirit of Gabaix and Maggiori (2015), where exchange rates are determined by the limited risk-bearing capacity of financial intermediaries in segmented international markets. In our framework, ψ accordingly measures how strongly the exchange rate must adjust to support a given external imbalance.[22]

Optimality conditions The intratemporal first-order condition, log-linearised around the deterministic steady state, yields the standard labour-supply relation

$$w_t - p_t = \sigma c_t + \varphi n_t \tag{13}$$

Let λ_t denote the Lagrange multiplier on (12). The envelope condition for consumption is

$$\lambda_t = \frac{C_t^{-\sigma}}{P_t}$$

Optimality with respect to the two bonds delivers the corresponding Euler equations. For the domestic bond,

$$1 = R_t \, \mathbb{E}_t \left[\beta \, \frac{\lambda_{t+1}}{\lambda_t} \right] \tag{14}$$

which is standard. For the foreign-currency bond,

$$\underbrace{1 + \psi b_t}_{\substack{\text{marginal cost of} \\ \text{foreign bond}}} = \underbrace{R_t^* \, \mathbb{E}_t \left[\beta \, \frac{\lambda_{t+1}}{\lambda_t} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right]}_{\substack{\text{marginal benefit of} \\ \text{foreign bond}}} \tag{15}$$

The marginal cost of an extra unit of the foreign-currency bond is determined by the marginal portfolio adjustment cost ψb_t. The marginal benefit is the expected discounted payoff, converted back into Home-currency consumption units through the gross exchange-rate change $\mathcal{E}_{t+1}/\mathcal{E}_t$. When the household is a net creditor abroad ($b_t > 0$), the adjustment cost raises the effective opportunity cost of holding the foreign bond, requiring a higher expected foreign return in equilibrium.

[22] This portfolio friction is among those originally proposed by Schmitt-Grohé and Uribe (2003) as devices to induce stationarity in small open economy models with incomplete markets.

Real UIP condition Log-linearising (14) and (15) around a deterministic zero-NFA steady state and combining them yields the following modified real UIP condition[23]

$$e_t^r = \mathbb{E}_t e_{t+1}^r + r_t^* - r_t - \psi b_t \tag{16}$$

where r_t^* and r_t are the foreign and domestic CPI-based real interest rates in log-deviations from steady state, and $b_t \equiv (\mathcal{B}_t - \bar{\mathcal{B}})/\bar{Y}$ is the NFA position in absolute deviation from steady state, scaled by steady-state output. Relative to the standard complete-market version of the UIP, condition (16) features an additional *financial wedge* $-\psi b_t$: at a larger NFA (creditor) position b_t, the marginal cost of holding the foreign asset is larger, which lowers the *effective* return on the same foreign asset, $r_t^* - \psi b_t$ for any given r_t^*. For given expectations and domestic real return r_t, that makes the domestic asset more convenient at the margin, inducing an appreciation of the current real exchange rate (a fall in e_t^r).

Imposing the no-bubble condition:

$$\lim_{J \to \infty} \mathbb{E}_t e_{t+J}^r = 0 \tag{17}$$

and iterating (16) forward yields the present-value representation

$$e_t^r = \underbrace{\sum_{j \geq 0} \mathbb{E}_t \left(r_{t+j}^* - r_{t+j} \right)}_{\text{expected real rate differentials}} - \underbrace{\psi \sum_{j \geq 0} \mathbb{E}_t \, b_{t+j}}_{\substack{\text{expected path of} \\ \text{net foreign assets}}} \tag{18}$$

Equation (18) is the relevant incomplete-market asset-pricing relation in our framework: the current real exchange rate reflects, alongside the conventional sum of expected real-rate differentials, the expected future path net foreign assets. Anticipated current account surpluses ($\mathbb{E}_t b_{t+j} > 0$ for some j) appreciate the real exchange rate today, with the strength of this channel governed by the financial segmentation parameter ψ. Yakhin (2022) shows that the above linearised UIP condition is isomorphic, up to first order, to the modified UIP equations of Gabaix and Maggiori (2015) and Fanelli and Straub (2021), as well as to the convex portfolio adjustment cost model of Schmitt-Grohé and Uribe (2003).

[23]Formally, the steady state features $\bar{\mathcal{B}} = 0$, $\bar{R} = \bar{R}^* = \beta^{-1}$, and $\bar{\mathcal{E}}_{t+1}^r / \bar{\mathcal{E}}_t^r = 1$, with $\mathcal{E}_t^r \equiv \mathcal{E}_t / P_t$.

4.2 Firms and Output Demand

Technology and pricing Domestic firms are monopolistically competitive and produce with the linear technology

$$Y_t = N_t$$

Under flexible domestic prices, firms set prices as a constant markup over nominal marginal cost. After the standard normalisation of the steady-state markup, the real product wage is constant up to first order,

$$w_t - p_{H,t} = 0 \tag{19}$$

Combining (19) with the household intratemporal condition (13) and using $n_t = y_t$, we obtain the static labour-supply relation

$$\sigma c_t + \varphi y_t = p_{H,t} - p_t \tag{20}$$

Intuitively, a deterioration in the terms of trade or a rise in the import tariff (both of which lower $p_{H,t} - p_t$) reduces the real wage, discouraging labour supply for any given level of consumption.

Export demand Let Y_t^* denote exogenous foreign output. Foreign demand for the Home good is

$$\mathrm{X}_t = \gamma \left(\frac{P_{H,t}}{\mathcal{E}_t} \right)^{-\eta} Y_t^* = \gamma \, S_t^{\eta} \, Y_t^*$$

where the second equality uses $S_t = \mathcal{E}_t / P_{H,t}$ and the parameter γ captures the degree of openness of the rest of the world to Home exports. A rise in S_t - equivalently, a depreciation of the Home good relative to foreign goods - boosts export demand with elasticity η.

Goods market clearing Market clearing for the Home good then reads

$$Y_t = C_{H,t} + \mathrm{X}_t = (1 - \nu) \, \mathcal{G}_t^{\eta} C_t + \gamma \, S_t^{\eta} Y_t^* \tag{21}$$

As in (10)-(11), both $\mathcal{G}_t$ and S_t are affected by the tariff: domestic absorption responds to the tariff through the CPI-PPI ratio, while export demand depends on the terms of trade.

PPI targeting We assume that monetary policy is specified as a PPI targeting rule,[24]

$$p_{H,t} = 0 \qquad \forall\ t$$

4.3 Effect of Transitory Tariffs on the Exchange Rate

We now characterise the effect of a transitory tariff innovation on both the real and the nominal exchange rates. We begin with a proposition showing that, in our setup, a temporary increase in tariffs unambiguously leads to an appreciation of the real exchange rate.

Proposition 1 (Real exchange-rate effect of a transitory tariff)**.** *Consider an i.i.d. innovation $\varepsilon_{T,t}$ to the import tariff, so that $\tau_t = \varepsilon_{T,t}$. The real exchange rate satisfies*

$$e_t^r = \Xi\, \varepsilon_{T,t},$$

where

$$\Xi \equiv -(1-\nu)\, A - \nu, \qquad A \equiv \frac{\varphi\, \Omega_\tau}{1 + \varphi\, \Omega_s},$$

and

$$\Omega_s \equiv \frac{(1-\nu)^2}{\sigma} + \eta\big[(1-\nu)\nu + \gamma\big], \qquad \Omega_\tau \equiv (1-\nu)\nu \left(\eta - \frac{1}{\sigma}\right).$$

The coefficient Ξ admits the equivalent closed-form representation

$$\Xi = -\,\frac{\nu\big[\,1 + \varphi\,\eta\,(1-\nu+\gamma)\,\big]}{1 + \varphi\,\Omega_s}\ <\ 0 \tag{22}$$

for any $\sigma, \eta, \varphi > 0$, $\nu \in (0,1)$, $\gamma \geq 0$. A transitory import tariff therefore appreciates the real exchange rate on impact, irrespective of the relative magnitude of η and $1/\sigma$.

Proof. See Appendix A.1. □

The response of the real exchange rate to a tariff shocks is governed by the coefficient Ξ, which summarizes two channels. The first is a *terms-of-trade* channel, $-(1-\nu)A$. Its sign is governed by Ω_τ, hence by the Cole–Obstfeld condition $\eta \gtrless 1/\sigma$. If trade substitution is strong ($\eta > 1/\sigma$), the terms of trade fall on impact and reinforce real appreciation. If instead consumption smoothing dominates ($\eta < 1/\sigma$), the terms of trade depreciate and this channel works in the opposite direction. The

[24]For real variables, this rule is equivalent to assuming that domestic prices are flexible. The PPI target is nonetheless useful in order to pin down nominal variables, such as the nominal exchange rate.

second is a *price-level* channel, $-\nu$: tariffs raise the CPI mechanically through the import share, and therefore always appreciate the real exchange rate.

Overall, Proposition 1 isolates the effect of a purely transitory tariff shock through current *terms of trade* and *relative prices*. Under incomplete financial markets, however, the persistence of future tariffs also shapes the real exchange rate. The effect of the future path of tariffs operates through the external balance, which we introduce next.

4.3.1 Temporary Tariffs and the Nominal Exchange Rate

The proof of Proposition 1 establishes that, under PPI targeting, the ex-tariff terms of trade satisfy $s_t = -A\,\varepsilon_{T,t}$ with $A \equiv \varphi\Omega_\tau/(1+\varphi\Omega_s)$. Because $p_{H,t} = 0$ implies $s_t = e_t$, this same equation pins down the impact response of the *nominal* exchange rate.

Proposition 2 (Nominal exchange-rate effect of a transitory tariff)**.** *Consider an i.i.d. innovation $\varepsilon_{T,t}$ to the import tariff, so that $\tau_t = \varepsilon_{T,t}$. Under PPI targeting, the nominal exchange rate satisfies*

$$e_t = -A\,\varepsilon_{T,t}, \qquad A \equiv \frac{\varphi\,\Omega_\tau}{1+\varphi\,\Omega_s}.$$

Since $\varphi > 0$ and $1+\varphi\Omega_s > 0$, the sign of the response is governed by Ω_τ, and hence by the Cole-Obstfeld-type condition

$$\operatorname{sign}\left(\frac{\partial e_t}{\partial \varepsilon_{T,t}}\right) \;=\; -\operatorname{sign}(\Omega_\tau) \;=\; -\operatorname{sign}\left(\eta - \frac{1}{\sigma}\right).$$

A transitory import tariff therefore:

(i) appreciates *the nominal exchange rate on impact iff $\eta > 1/\sigma$;*

(ii) depreciates *the nominal exchange rate on impact iff $\eta < 1/\sigma$;*

(iii) leaves the nominal exchange rate unchanged in the knife-edge case $\eta = 1/\sigma$.

Proof. See Appendix A.1. □

Hence, while the *real* exchange rate appreciates on impact for all admissible parameter values, the *nominal* exchange rate response is conditional and tracks the Cole-Obstfeld threshold $\eta = 1/\sigma$: when expenditure-switching dominates consumption-smoothing ($\eta > 1/\sigma$), the terms of trade improve and the currency appreciates; when consumption-smoothing dominates expenditure-switching ($\eta < 1/\sigma$), households reallocate their tariff-induced loss in purchasing power intertemporally rather than across goods, the terms of trade deteriorate, and the currency *depreciates.*

4.3.2 NFA and the intertemporal budget constraint

Next we derive an expression for net foreign asset (NFA) accumulation. Starting from the household budget constraint in (12), using a zero net supply equilibrium condition for domestic bonds, and the expression for profits, we can write:

$$P_t C_t + \mathcal{E}_t B_t^* + P_t \frac{\psi}{2} \left(\frac{\mathcal{B}_t - \bar{\mathcal{B}}}{\bar{Y}} \right)^2 = P_{H,t} Y_t + T_t + R_{t-1}^* \mathcal{E}_t B_{t-1}^*$$

We then use the tariff-inclusive expenditure identity together with the lump-sum tariff rebate to obtain

$$\mathcal{E}_t B_t^* + P_t \frac{\psi}{2} \left(\frac{\mathcal{B}_t - \bar{\mathcal{B}}}{\bar{Y}} \right)^2 = R_{t-1}^* \mathcal{E}_t B_{t-1}^* + \underbrace{(P_{H,t} Y_t - P_{H,t} C_{H,t} - \mathcal{E}_t C_{F,t})}_{P_t TB_t} \tag{23}$$

where TB_t denotes the real trade balance. Dividing (23) by P_t and using $\mathcal{E}_t^r \equiv \mathcal{E}_t / P_t$ yields the exact real law of motion for net foreign assets:

$$\mathcal{B}_t = R_{t-1}^* \frac{\mathcal{E}_t^r}{\mathcal{E}_{t-1}^r} \mathcal{B}_{t-1} + TB_t - \frac{\psi}{2} \left(\frac{\mathcal{B}_t - \bar{\mathcal{B}}}{\bar{Y}} \right)^2 \tag{24}$$

A first-order approximation of (24) around the balanced-trade deterministic steady state with zero foreign-bond position yields[25]

$$b_t = \beta^{-1} b_{t-1} + tb_t \tag{25}$$

where $tb_t \equiv (TB_t - \overline{TB})/\bar{Y}$ and b_{t-1} is a pre-determined bond position.

Intertemporal budget constraint To pin down the trajectory of b_t, we impose two conditions: a pre-determined bond position $b_{t-1} = 0$, and the transversality condition $\lim_{J \to \infty} \beta^J \mathbb{E}_t \{ b_{t+J} \} = 0$, which rules out Ponzi schemes. Iterating (25) forward yields the intertemporal external balance condition

$$b_t = -\sum_{j=1}^{\infty} \beta^j \, \mathbb{E}_t \left\{ tb_{t+j} \right\} \tag{26}$$

[25]The steady state features $\overline{TB} = 0$, $\bar{\mathcal{B}} = 0$, and $R^* = \beta^{-1}$.

Equation (26) links inversely the current net foreign asset position to the present discounted value of future trade surpluses. Consider then the UIP condition (16). For any given real interest rate differential, a reduction in net foreign assets b_t (equivalently, increased foreign borrowing) depreciates the real exchange rate. In turn, from 26, this requires expectations of future trade balance surpluses.

4.4 Structural Trade-Policy Uncertainty

We now explicitly incorporate *structural* trade-policy uncertainty into the model. We assume that tariffs follow an exogenous stochastic process with two components: an underlying *persistent trade-policy regime* and a *transitory tariff disturbance*. The persistent stance - or systematic orientation of trade policy - governs the expected future path of tariffs. The transitory disturbance, by contrast, moves the tariff currently in force but carries no independent information about future tariffs.
Firms and households observe the current tariff, but not its decomposition. They therefore do not know whether a tariff movement reflects a persistent change in the trade-policy regime or a short-lived tariff wedge. The inference problem is inherently forward-looking: agents use the observed tariff to infer the latent persistent component, and therefore the expected future tariff path.

Tariff process We formalize this inference problem as the linear Gaussian state-space system

$$\begin{cases} \tau_{S,t} = \rho_S \tau_{S,t-1} + \varepsilon_{S,t}, & \varepsilon_{S,t} \sim \mathcal{N}(0, \sigma_S^2), \\ \tau_t = \tau_{S,t} + \varepsilon_{T,t}, & \varepsilon_{T,t} \sim \mathcal{N}(0, 1). \end{cases} \tag{27}$$

The latent state $\tau_{S,t}$ is the persistent trade-policy regime, with near-unit persistence $\rho_S \simeq 1$ and innovation variance σ_S^2. The observed signal τ_t is the tariff currently in force, and the transitory tariff disturbance $\varepsilon_{T,t}$ has its variance normalized to one.

Structural TPU We define *Structural* Trade-Policy Uncertainty as S-TPU $\equiv \sigma_S^2$, the volatility of innovations to the persistent policy stance. S-TPU is not uncertainty about today's tariff rate; it is uncertainty about how to *interpret* a tariff movement - whether it reflects a persistent shift in the trade-policy regime or a transitory tariff wedge. We now show that S-TPU governs this interpretation through the agent's posterior split of the tariff surprise.

Tariff surprise Agents enter period t with a prior $\mathbb{E}_{t-1}\{\tau_{S,t}\}$ over the latent stance, formed from the history of observed tariffs. Upon observing τ_t, they face the *tariff* *surprise*, defined as the one-step-ahead forecast error of the observed tariff,

$$\zeta_t \equiv \tau_t - \mathbb{E}_{t-1}\{\tau_{S,t}\}$$

By the state-space system (27), the tariff surprise admits the structural decomposition

$$\underbrace{\zeta_t}_{\text{tariff surprise}} = \underbrace{\big(\tau_{S,t} - \mathbb{E}_{t-1}\{\tau_{S,t}\}\big)}_{\text{persistent policy-stance surprise}} + \underbrace{\varepsilon_{T,t}}_{\text{transitory tariff disturbance}} \tag{28}$$

The two components have very different implications. A persistent policy-stance surprise propagates at rate $\rho_S \simeq 1$ and shifts the entire expected future tariff path; a transitory tariff disturbance dies next period. Agents observe ζ_t but not its decomposition, and must infer it from contingent tariff information at time-t.

Bayesian split of tariff surprise The Bayesian updating of the state-space system in (27) delivers the optimal decomposition of the realized tariff surprise into a posterior persistent component and a transitory component.[26] We call it the *Bayesian split*:

$$\underbrace{\zeta_t}_{\text{tariff surprise}} = \underbrace{\mathbb{K}(\sigma_S^2)\,\zeta_t}_{\substack{\text{share attributed to}\\ \text{persistent stance}}} + \underbrace{\big(1 - \mathbb{K}(\sigma_S^2)\big)\,\zeta_t}_{\substack{\text{share attributed to}\\ \text{transitory disturbance}}} \tag{29}$$

where $\mathbb{K}(\sigma_S^2) \in (0, 1)$ is the Kalman gain, strictly increasing in S-TPU. For a given tariff surprise ζ_t, the S-TPU determines the share $\mathbb{K}(\sigma_S^2)$ of the surprise that agents optimally attribute to the persistent policy stance; $1 - \mathbb{K}(\sigma_S^2)$ is the residual share attributed to the transitory tariff disturbance.

Role of S-TPU S-TPU pins down the agent's *Bayesian split* (29) of a given realized surprise.[27] When S-TPU is high, agents have low confidence in their prior about the persistent stance and optimally place greater weight on the current tariff as a signal of the persistent component: a larger share of ζ_t is read as a persistent policy-stance surprise, and the entire expected future tariff path shifts. When S-TPU is low, agents trust their prior, attribute most of the surprise to the transitory tariff disturbance, and barely revise the expected path. In this sense, S-TPU determines whether agents interpret the current tariff shock as persistent or transitory.

[26]Online Appendix C reports the formal derivation and the steady-state Kalman gain.

[27]Note that the S-TPU does not alter the structural decomposition (28) - the structural decomposition is a property of the data-generating process.

Illustration: a purely transitory tariff To fix ideas, consider a one-period transitory spike in the tariff rate: $\tau_0 = \varepsilon_{T,0} > 0$, $\varepsilon_{T,t} = 0$ for $t \geq 1$, and $\tau_{S,t} = 0$ throughout. Under the natural prior $\mathbb{E}_{-1}\{\tau_{S,0}\} = 0$, the date-0 tariff surprise coincides with the structural shock, $\zeta_0 = \tau_0 = \varepsilon_{T,0}$. Even though the disturbance is purely transitory, agents misattribute a share $\mathbb{K}(\sigma_S^2)$ of it to the persistent stance, raising the one-step-ahead forecast to

$$\mathbb{E}_0\{\tau_1\} \;=\; \rho_S \cdot \underbrace{\mathbb{K}(\sigma_S^2)\,\varepsilon_{T,0}}_{\substack{\text{impact}\\\text{misattribution}}}$$

From $t \geq 1$ onwards the observed tariff returns to zero and the filter gradually unwinds this misattribution, generating a path of tariffs beliefs:

$$\underbrace{\mathbb{E}_t\{\tau_{t+1}\}}_{\text{path of tariffs beliefs}} = \rho_S \cdot \underbrace{\Big(\rho_S\;\big(1 - \mathbb{K}(\sigma_S^2)\big)\Big)^t}_{\text{belief decay}} \underbrace{\mathbb{K}(\sigma_S^2)\,\varepsilon_{T,0}}_{\text{impact misattribution}}, \qquad t \geq 0. \tag{30}$$

Notice that the same Kalman gain governs two opposing forces. For one, a higher S-TPU raises the impact misattribution - lifting the initial revision. Simultaneously, however, a higher S-TPU accelerates the belief decay, because subsequent zero observations become more informative. Higher S-TPU therefore amplifies the initial revision while shortening its half-life: the path of tariffs beliefs becomes more front-loaded as S-TPU rises.

4.5 Exchange Rate Persistence Channel

We have established that S-TPU governs the share of a realized tariff surprise that agents attribute to the persistent stance, and hence the extent to which a tariff shock lifts the expected future tariff path. This section shows that the revision of expected future tariffs activates a forward-looking *persistence channel* on the real exchange rate which would be absent in the case of certainty of the trade policy. We isolate the persistence channel in two steps. First, we show how the real UIP condition (18) prices the transitory tariff shock under S-TPU into the current real exchange rate. Second, we embed this force in the general equilibrium of the model, where consumption, output, and the terms of trade all adjust endogenously.

We first state the following Proposition on the link between S-TPU and the real exchange rate under purely *temporary* tariffs.

Proposition 3 (Real UIP under S-TPU)**.** *Under incomplete financial markets and PPI targeting, consider a purely transitory tariff shock $\varepsilon_{T,t}$. Under the natural prior*

$\mathbb{E}_{t-1}\{\tau_{S,t}\} = 0$, *the modified real UIP condition under S-TPU reads:*

$$e_t^r = \underbrace{\sum_{j\geq 0} \mathbb{E}_t\{r^*_{t+j} - r_{t+j}\}}_{\text{expected real rate differentials}} + \underbrace{\psi\,\Gamma(\rho_S)\,\Lambda\,\mathbb{K}(\sigma_S^2)\,\varepsilon_{T,t}}_{\text{estimated persistence effect}}, \tag{31}$$

where

$$\Lambda \equiv \frac{\Omega_\tau}{1+\varphi\Omega_s} - \frac{\Xi}{\sigma} + \nu A, \qquad A \equiv \frac{\varphi\Omega_\tau}{1+\varphi\Omega_s}, \qquad \Xi \equiv -(1-\nu)A - \nu,$$

and

$$\Gamma(\rho_S) \equiv \frac{\beta\rho_S}{(1-\rho_S)(1-\beta\rho_S)}, \qquad \Gamma'(\rho_S) > 0.$$

Proof sketch. Start from the forward real UIP in (18). We want to show that, under S-TPU, a transitory tariff enters the expected path of net foreign assets, $-\sum_{j\geq 0}\mathbb{E}_t b_{t+j}$. At the flexible-price PPI allocation, tariffs enter the external balance as $tb_t = \Lambda\tau_t$. By equation (29), the firms and households assign the share $\mathbb{K}(\sigma_S^2)$ of the tariff surprise to the persistent stance. The tariff surprise therefore shifts the expected *future* trade-balance path. The intertemporal budget constraint in (26) cumulates this path into

$$-\sum_{j\geq 0}\mathbb{E}_t b_{t+j} = \Gamma(\rho_S)\Lambda\mathbb{K}(\sigma_S^2)\varepsilon_{T,t}$$

Substitute into the forward real UIP in (18) and obtain (31). See Appendix A.2 for a more detailed proof. □

The first term in (31) is the standard expected sequence of real rate differentials featured in the UIP condition. We focus on the second term, the *estimated persistence channel.* Notice that, since the tariff shocks are strictly i.i.d., the persistence channel would be zero in the case of certainty, i.e., $\mathbb{K}(\sigma_S^2) = 0$. Under tariff policy uncertainty, however, what matters is not the true persistence of the shock but its *perceived* persistence at the time the tariff shock hits the economy: a primitive shock can be transitory and still move the real exchange rate through the intertemporal block if, on impact, agents assign part of the realized surprise to the persistent stance of the tariff policy. While the tariff shock is transitory in the data-generating process, agents partly filter it into $\tau_{S,t}$, lifting *expected future* tariffs and, with $\Lambda > 0$, expected future trade balances.[28] In turn, this affects the real exchange rate via the

[28] The sign conditions for parameter Λ are as follows. Defining $\kappa \equiv (1-\nu)/\sigma + \nu > 0$, one can write $\Lambda = \frac{\Omega_\tau(1+\phi\kappa)}{1+\phi\Omega_s} + \frac{\nu}{\sigma}$. The second term is unambiguously positive, the first term inherits the sign of $\Omega_\tau = (1-\nu)\nu(\eta - 1/\sigma)$. Hence $\Lambda > 0$ holds unambiguously whenever $\eta \geq 1/\sigma$. When

financial wedge in the modified UIP condition (16).
The strength of the estimated persistence effect is governed by three key parameters in (31).[29] A higher S-TPU raises the Kalman gain $\mathbb{K}(\sigma_S^2)$ and scales the response of e_t^r in proportion. A higher financial-segmentation parameter ψ steepens the external financing schedule faced by the domestic household: a given NFA adjustment requires a larger movement of the exchange rate to induce private intermediaries to absorb it, so the depreciation generated by any given misperception is amplified. A higher persistence parameter ρ_S raises the factor $\Gamma(\rho_S)$, scaling the impact of future trade balances onto the exchange rate.

General-equilibrium response In the general equilibrium of the model, consumption, output, and the terms of trade adjust to both the current-tariff and the estimated-persistent tariff. The real exchange rate therefore reflects two distinct objects - the current tariff in force and the posterior estimate of the persistent component. The following proposition separates these two components.

Proposition 4 (General-equilibrium decomposition of the real exchange rate)**.** *Under flexible prices, PPI targeting, and incomplete financial markets, the real exchange rate satisfies*

$$e_t^r = \underbrace{\Xi\,\tau_t}_{\text{current-tariff effect}} + \underbrace{\Phi^{GE}\,\mathbb{E}_t\{\tau_{S,t}\}}_{\text{estimated persistence effect}}, \tag{32}$$

where

$$\Xi \equiv -(1-\nu)A - \nu, \qquad A \equiv \frac{\varphi\Omega_\tau}{1+\varphi\Omega_s},$$

and

$$\Phi^{GE} \equiv \frac{(1-\nu)\psi\big(1+\varphi\frac{1-\nu}{\sigma}\big)}{1+\varphi\Omega_s}\,\Lambda\,\Gamma(\rho_S). \tag{33}$$

Proof sketch. The *current tariff* enters the real exchange rate directly through the contemporaneous terms of trade and CPI, delivering the loading Ξ of Proposition 1. The *estimated-persistence* effect is an intertemporal channel: it revises the expected path of future trade balances, thereby changing the cumulated NFA position priced into e_t^r through the forward UIP (18). In general equilibrium, this NFA-driven movement in e_t^r feeds back through consumption (via risk sharing) and terms of trade (via goods-market clearing) - the two forces rescale the response and deliver

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$\eta < 1/\sigma$, $\Lambda > 0$ requires:

$$1+\phi\Omega_s \;>\; (1-\nu)(1-\sigma\eta)(1+\phi\kappa),$$

a condition satisfied at calibrations with sufficiently low trade elasticity.

[29] The remaining coefficients are positive under standard parameterizations and act as scale factors. We treat them as such throughout.

the loading Φ^{GE}.[30] See Appendix A.3 for a more detailed proof. □

The above decomposition isolates two distinct forces. The first term is the current-tariff effect, which is active under certainty, and, with $\Xi < 0$, delivering an *impact appreciation*. The second term is the estimated persistence effect, operating through the expected tariff path, the expected trade balance with elasticity $\Lambda > 0$, and the NFA wedge in (16), with $\Phi^{GE} > 0$ delivering a real *depreciation* today whenever the inferred persistent stance rises. S-TPU enters (32) exclusively through the second term. The estimated persistence effect scales with the Kalman gain through $\mathbb{E}_t\{\tau_{S,t}\}$: a higher S-TPU raises the share of any tariff surprise filtered into the persistent stance and magnifies the persistence term. The same term is larger when financial market frictions are more severe (through parameter ψ), when the estimated stance is more persistent, through $\Gamma(\rho_S)$, and when the trade-balance loading Λ is larger.

Impact response to a transitory tariff shock Consider a purely transitory tariff shock $\varepsilon_{T,t} > 0$ with the persistent stance set at its steady-state value. Under the natural prior, $\zeta_t = \varepsilon_{T,t}$. The Kalman update implies

$$\mathbb{E}_t\{\tau_{S,t}\} = \mathbb{K}(\sigma_S^2)\varepsilon_{T,t}$$

Substituting into (32) yields:

$$\frac{de_t^r}{d\varepsilon_{T,t}} = \underbrace{\Xi}_{\text{current-tariff effect}} + \underbrace{\Phi^{GE}\,\mathbb{K}(\sigma_S^2)}_{\text{estimated persistence effect}} \tag{34}$$

Equation (34) is the impact decomposition of a purely transitory tariff surprise. The same tariff shock generates two opposing forces. The current tariff appreciates the real exchange rate through $\Xi < 0$. The estimated persistent component depreciates the real exchange rate through $\Phi^{GE}\mathbb{K}(\sigma_S^2)$. As S-TPU rises, the second force can prevail: a larger share of the realized surprise is absorbed into beliefs about the persistent stance. Hence there exists a level of S-TPU at which the impact response switches sign. Above that level, the estimated persistence effect dominates and the same transitory tariff shock depreciates the real exchange rate.

Special case: complete information Notice that in the benchmark case of *complete* information, agents observe the structural decomposition of the tariff surprise

[30] Whether the general equilibrium effect magnifies or dampens the response depends on the specific model parameterization.

realization. A transitory shock is recognized as transitory, so $\mathbb{E}_t\{\tau_{S,t}\} = 0$ and the estimated persistence effect is nil. The impact response is simply $de_t^r/d\varepsilon_{T,t} = \Xi < 0$, as in the flexible-price benchmark. Therefore, imperfect information *per se* makes the shock persistent in beliefs. In turn, incomplete markets make that belief-driven expected trade-balance path relevant for the real exchange rate.

4.6 Simulation of Transitory Tariff Shocks

Next we simulate the model to illustrate the quantitative implications of the mechanism developed above. Our exercise computes impulse responses of the real exchange rate and other selected variables to a purely *transitory* tariff shock under alternative levels of S-TPU.

Simulation method In the simulation, the model is solved as a deterministic transition back to the steady state, with the transversality condition on net foreign assets in (26) imposed as a terminal condition at a finite horizon.[31] We compute the model response to a purely transitory tariff shock: the tariff rises on impact and then immediately returns to steady state, $\{\varepsilon_{T,0},\ 0,\ 0,\ \ldots\}$, leaving the true persistent policy stance unchanged. Under incomplete information, this sequence of realized tariffs induces a path of one-step-ahead expected tariffs $\{\tau_0,\ \tau_1,\ \tau_2,\ \ldots\}$. This sequence of expected tariff is derived in (30), and it is jointly determined by the persistence of the latent stance, ρ_S, and by the steady-state Kalman gain, $\mathbb{K}(\sigma_S^2)$, which governs how much of each tariff surprise is assigned to the persistent component.[32]

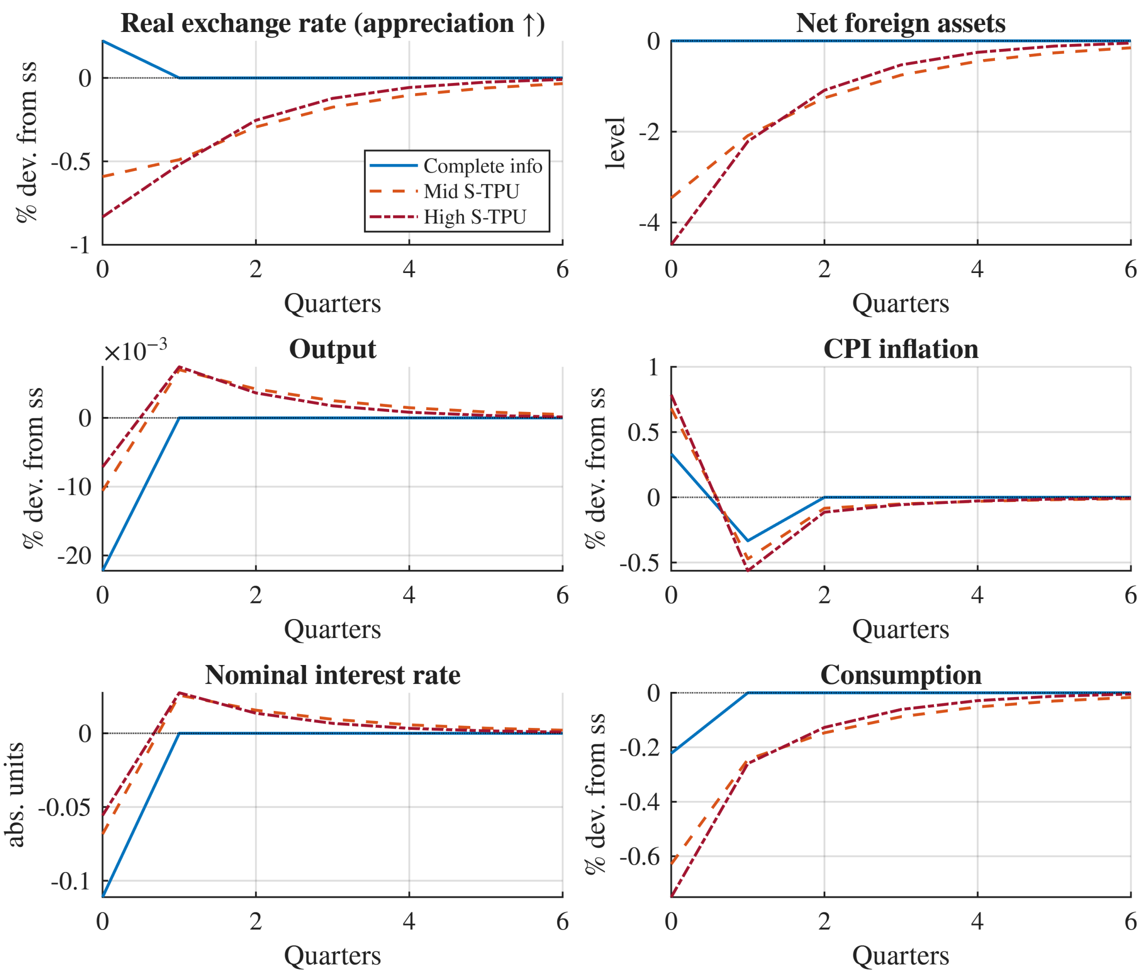
Calibration We calibrate the model using standard values from the open-economy New Keynesian literature (Monacelli, 2026). We set the import share to $\nu = 0.3$ and choose the degree of openness to the foreign economy $\gamma = 0.3$, so that the two are symmetric. The trade elasticity is set to $\eta = 0.5$, consistent with the low-elasticity estimates surveyed in Itskhoki and Mukhin (2021). We set the inverse intertemporal elasticity of substitution to $\sigma = 1$, the inverse Frisch elasticity to $\varphi = 5$ (Galí, 2015), and the quarterly discount factor to $\beta = 0.99$. The financial-segmentation parameter is small, $\psi = 0.01$, following Schmitt-Grohé and Uribe (2003). We set

[31] Implementation uses Dynare's `perfect_foresight_solver`. The transition horizon is set to $J = 200$ quarters, and terminal values are set at steady state, which approximates $\beta^J \mathbb{E}_t\{b_{t+J}\} = 0$.

[32] The state-space model for tariff beliefs is given in (27). The illustration in (30) derives the expected tariff path generated by a transitory tariff innovation. For an innovation $\varepsilon_{T,0}$, the implied sequence is $\tau_0 = \varepsilon_{T,0}$ and $\mathbb{E}_t\{\tau_{t+1}\} = \rho_S \cdot \Big(\rho_S\ (1 - \mathbb{K}(\sigma_S^2))\Big)^t\ \mathbb{K}(\sigma_S^2)\, \varepsilon_{T,0}$ for $t \geq 0$.

the persistence of the latent trade-policy regime to $\rho_S = 0.975$, reflecting the slow-moving nature of trade-policy regimes. Changes in tariff policy typically originate in trade agreements, political administrations, or geopolitical alignments, all of which evolve slowly relative to the business cycle. Finally, we consider three illustrative values of S-TPU, $\sigma_S^2 \in \{0, 0.25, 0.5\}$. These span complete information ($\sigma_S^2 = 0$, $\mathbb{K}(\sigma_S^2) = 0$), medium uncertainty, and high uncertainty.

Figure 11: Simulated impulse responses to an *i.i.d.* import-tariff shock



Notes: Impulse responses under complete information (blue) versus alternative levels of Structural Trade-Policy Uncertainty (orange and red). *Sign convention in the figure:* the top left panel plots the real exchange rate so that a fall denotes a depreciation, i.e. the negative of e_t^r.

Impulse responses Figure 11 displays impulse responses to a one-period, 1 p.p. increase in import tariffs under PPI targeting. There are three scenarios: a complete-information benchmark, $\sigma_S^2 = 0$, and two S-TPU cases: a mid-uncertainty economy, $\sigma_S^2 = 0.25$, and a high-uncertainty regime, $\sigma_S^2 = 0.5$.

Consider first the real exchange rate. Under complete information, agents recognize the tariff increase as purely transitory. The exchange rate therefore responds only through the contemporaneous terms-of-trade and price-level channels, generating the impact *appreciation* characterized in Proposition 1; since the tariff immediately reverts, the response dies out after one period. Under S-TPU, the same realized tariff increase also conveys information about the latent persistent trade-policy stance. Through the Bayesian split in (29), agents attribute part of the tariff surprise to a persistent policy-stance shock, revise upward the expected future tariff path, and activate the persistence channel. Agents decrease their current holdings of net foreign assets (increase borrowing) in the expectation of higher future trade balances induced by higher future expected tariffs. In turn, a lower net foreign asset position depreciates the real exchange rate through the forward-looking UIP condition (16). At the calibrated values, this estimated-persistence effect dominates the complete-information force. The same tariff shock therefore *depreciates* the real exchange rate on impact.

The response of net foreign assets makes this mechanism explicit. Under complete information, the NFA response is muted, because a purely transitory tariff does not shift the expected future trade-balance path. Under S-TPU, instead, agents infer a positive persistent component from the tariff surprise. Expected future tariffs rise and, through the trade-balance mapping, so do expected future trade surpluses. The intertemporal external-balance condition in (26) then implies that the economy borrows against those future surpluses, generating an impact decline in b_t. Through the modified UIP condition in (16), this NFA decline is priced into the current real exchange rate.

Output displays the real-side counterpart of the exchange-rate response. As discussed in Monacelli (2026) - under certainty - the output effect of a transitory tariff shock depends on the trade elasticity η.[33] In our calibration, output *falls* on impact and returns to steady state after one period. Under S-TPU, the impact contraction is muted and output subsequently rises above steady state. The belief-driven depreciation raises foreign demand for the Home good. This export-demand effect offsets part of the direct contractionary effect of the tariff on domestic activity and temporarily dominates after impact. The overshoot is stronger under high S-TPU, where the initial depreciation is larger.

CPI inflation rises on impact in all three cases. Under complete information, the increase reflects the direct pass-through of the tariff into import prices. Under

[33]Equation (A.37) shows that the general-equilibrium response of output to a tariff shock is summarized by the coefficient Ω_τ, whose sign depends on the Cole-Obstfeld condition, $\eta \gtreqless 1/\sigma$.

S-TPU, the tariff also induces a real depreciation, which further raises the domestic-currency price of imports and boosts CPI inflation. Inflation reverts below steady state in one quarter reflecting the transitory nature of the realized tariff. The fall is larger under S-TPU because the belief-driven depreciation also unwinds, reinforcing the decline in the tariff-inclusive import price.

The nominal interest rate falls on impact in all three cases. The cut is smaller under S-TPU because the belief-driven depreciation raises expected CPI inflation: for a given nominal rate, this already lowers the CPI real rate faced by households. Implementing the PPI-targeting allocation therefore requires less of a nominal-rate cut than under complete information.

Consumption falls in all three cases. Under S-TPU, agents revise upward the expected future tariff path, generating a persistent increase in tariff-inclusive import prices. Consumption therefore falls by more and recovers only gradually.

Finally, note that the impact response of all variables scales with S-TPU, as a larger Kalman gain assigns more weight to the observed tariff signal. This does not imply more persistent belief dynamics. The same gain that amplifies the initial revision also makes subsequent observations more informative. Hence, when no further tariff increases materialize, the posterior estimate of the persistent stance is revised down more quickly, as shown by the rolling forecasts in (30). Higher S-TPU therefore raises the impact response but makes the belief-induced propagation more front-loaded, with a shorter half-life.

5 Conclusions

We have shown that, in U.S. data after 1990, import tariff shocks generate a persistent depreciation of the U.S. dollar, overturning the textbook prediction of currency appreciation through expenditure-switching. We have argued that a possible key to understanding this result lies in *structural* trade-policy uncertainty (S-TPU), defined as the uncertainty agents face about the *persistence* of the underlying trade-policy regime. This component of trade policy uncertainty leads agents to misperceive transitory tariff shocks as durable regime shifts, and activates a forward-looking channel that, relative to the standard case of policy certainty, can overturn the sign of the exchange-rate response.

More specifically, our paper makes four contributions. First, we propose a *narrative-dominance* identification strategy for tariff shocks in a Bayesian VAR on U.S. quarterly data, combining a sign restriction on real imports with historical-contribution restrictions imposed at well-documented narrative episodes. We find that a positive tariff shock contracts real activity, generates an S-shaped response of CPI inflation, improves the trade balance ratio at first and then deteriorates it at the medium horizon, induces an accommodative monetary-policy response, and produces a persistent depreciation of both the nominal and the real U.S. dollar effective exchange rate - in stark contrast to the textbook prediction.

Second, we construct a novel measure of S-TPU, designed to capture uncertainty about the *persistence* of the trade-policy regime rather than about the level of the tariff in force. S-TPU is estimated within a state-space stochastic-volatility model of tariff rates. Unlike the aggregate TPU index from Caldara et al. (2020), S-TPU rises around episodes of genuine regime change and remains muted around inconsequential (”noisy”) tariff announcements.

Third, we document that the empirical transmission of tariff shocks is *state-dependent* in S-TPU. The textbook implications - exchange-rate appreciation, monetary-policy tightening, higher output and inflation - prevail in states of low S-TPU. Conversely, in states of high S-TPU, the same tariff shock generates an exchange rate depreciation and a more accommodative monetary-policy response. The asymmetry vanishes when conditioning on the aggregate TPU index, suggesting that it is structural - not noise-driven - uncertainty that governs the international transmission of tariff shocks.

Fourth, we build a small open-economy New Keynesian model with incomplete international financial markets and uncertainty about the persistence of the tariff regime that rationalizes the above evidence. Agents observe the tariff currently in place but not its decomposition into a persistent stance and a transitory disturbance, and therefore *misperceive* strictly transitory shocks as embedding a persistent component. Under incomplete markets, this misperception leads households to borrow against expected future trade surpluses, thereby deteriorating the net foreign asset position and depreciating the current real exchange rate. S-TPU governs the relative weight of the conventional expenditure-switching channel vs. the novel *persistence channel* of the exchange rate: above a threshold, the latter dominates and overturns the sign of the exchange-rate response.

Taken together, our results show that the textbook association between tariffs and currency appreciation is neither a robust empirical regularity nor a general theoretical implication of dynamic equilibrium open-economy models. Once agents face uncertainty about the persistence of the trade-policy regime and international financial markets are incomplete, structural trade-policy uncertainty becomes a key determinant of the macroeconomic effects of tariff shocks.

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A Detailed proofs

A.1 Proof of Propositions 1 and 2

We aim to derive the response of the nominal and real exchange rate in response to a tariff shock. To obtain this, we start by fixing the response of the terms-of-trade s_t. Home-goods demand (10) gives $c_{H,t} = c_t + \eta\nu(s_t + \tau_t)$, and foreign demand at $y_t^* = 0$ reduces to $x_t = \eta s_t$. Log-linearising goods-market clearing (21) around the symmetric steady state obtains:

$$y_t = (1-\nu)\, c_t + \eta(1-\nu)\nu\big(s_t + \tau_t\big) + \eta\gamma\, s_t \tag{A.35}$$

Under complete information and a purely transitory innovation, the cumulated-NFA component drops from the real UIP, as b_t is predetermined. The international risk sharing reads

$$\sigma\, c_t = e_t^r = (1-\nu)\, s_t - \nu\, \tau_t \tag{A.36}$$

Substituting (A.36) into (A.35) and collecting terms,

$$y_t = \Omega_s\, s_t + \Omega_\tau\, \tau_t \tag{A.37}$$

with

$$\Omega_s \equiv \frac{(1-\nu)^2}{\sigma} + \eta\big[(1-\nu)\nu + \gamma\big], \qquad \Omega_\tau \equiv (1-\nu)\nu\left(\eta - \frac{1}{\sigma}\right)$$

Under flexible prices $y_t = y_t^n$. The firm's optimality condition with $p_{H,t} = 0$ gives $w_t = 0$, so the labour-supply schedule (20) becomes $-p_t = \sigma c_t + \varphi y_t^n$. Substituting $p_t = \nu(s_t + \tau_t)$ and (A.36) yields $y_t^n = -s_t/\varphi$. Equating with (A.37) and setting $\tau_t = \varepsilon_{T,t}$,

$$s_t = -A\, \varepsilon_{T,t}, \qquad A \equiv \frac{\varphi\, \Omega_\tau}{1 + \varphi\, \Omega_s} \tag{A.38}$$

We have established the response of the terms of trade to a tariff shock. By definition $s_t \equiv e_t - p_{H,t}$, and PPI targeting fixes $p_{H,t} = 0$, so the nominal exchange rate and the terms of trade coincide: $s_t = e_t$. This establishes Proposition 2.

Consider the log-linearised CPI (9), which collapses to $p_t = \nu(s_t + \tau_t)$, hence

$$e_t^r = (1-\nu)\, s_t - \nu\, \tau_t \tag{A.39}$$

Substituting (A.38) into (A.39),

$$e_t^r = \Xi\, \varepsilon_{T,t}, \qquad \Xi \equiv -(1-\nu)\, A - \nu$$

which establishes Proposition 1. $\square$

A.2 Proof of Proposition 3

We derive the exchange-rate response generated by the external-balance channel. With tariff revenue rebated lump sum, the trade balance at world prices is $TB_t = P_{H,t}Y_t - P_{H,t}C_{H,t} - \mathcal{E}_t P_F^* C_{F,t}$. Define $tb_t \equiv (TB_t/P_t - \overline{TB^r})/\bar{Y}$. Around the balanced-trade steady state, using $p_{H,t} - p_t = -\nu(s_t + \tau_t)$ and $T_t/(P_t\bar{Y}) = \nu\tau_t$, a first-order expansion gives

$$tb_t = y_t - c_t - \nu s_t \tag{A.40}$$

We evaluate (A.40) at the PPI flex-price allocation derived in Appendix A.1. From (A.38), $s_t = -A\tau_t$. Combining this with (A.37) gives $y_t = (\Omega_\tau - \Omega_s A)\tau_t$. Finally, (A.36) and $e_t^r = \Xi\tau_t$ imply $c_t = (\Xi/\sigma)\tau_t$. Substituting these three expressions into (A.40),

$$tb_t = \left(\Omega_\tau - \Omega_s A - \frac{\Xi}{\sigma} + \nu A\right)\tau_t$$

Using $\Omega_\tau - \Omega_s A = \Omega_\tau/(1 + \varphi\Omega_s)$, we obtain[34]

$$tb_t = \Lambda\tau_t, \qquad \Lambda \equiv \frac{\Omega_\tau}{1 + \varphi\Omega_s} - \frac{\Xi}{\sigma} + \nu A \tag{A.41}$$

Under the natural prior $\mathbb{E}_{-1}\{\tau_{S,0}\} = 0$, the date-$t$ surprise equals the realized innovation. By equation (29), firms and households assign the share $\mathbb{K}(\sigma_S^2)$ of the tariff surprise to the persistent stance. The Kalman update therefore gives

$$\mathbb{E}_t\{\tau_{S,t}\} = \mathbb{K}(\sigma_S^2)\varepsilon_{T,t}$$

Since transitory disturbances have zero conditional mean, expected future tariffs inherit only the perceived persistent component:

$$\mathbb{E}_t\{\tau_{t+j}\} = \rho_S^j \mathbb{K}(\sigma_S^2)\varepsilon_{T,t}, \qquad j \geq 1$$

Combining this path with (A.41) yields

$$\mathbb{E}_t\{tb_{t+j}\} = \Lambda\rho_S^j \mathbb{K}(\sigma_S^2)\varepsilon_{T,t}, \qquad j \geq 1$$

[34] This evaluates the trade balance at the allocation that obtains absent the financial friction. The exact static trade balance also depends on the cumulated-NFA path, so that $tb_t = \Lambda\tau_t + \Lambda_F F_t$ with $F_t \equiv \psi\sum_{j\geq 1}\mathbb{E}_t b_{t+j}$. Solving the resulting fixed point gives $F_t = O(\psi^2)$, so (31) is accurate to first order in ψ.

Substituting into the intertemporal budget constraint (26),

$$\sum_{j\geq 0}\mathbb{E}_t b_{t+j} = -\sum_{j\geq 0}\sum_{k\geq 1}\beta^k\,\mathbb{E}_t\{tb_{t+j+k}\} = -\Gamma(\rho_S)\,\Lambda\,\mathbb{K}(\sigma_S^2)\,\varepsilon_{T,t} \tag{A.42}$$

where $\Gamma(\rho_S) \equiv \frac{\beta\rho_S}{(1-\rho_S)(1-\beta\rho_S)}$. Finally, substituting this NFA path into the forward UIP (18) delivers (31). Since

$$\Gamma'(\rho_S) = \frac{\beta(1-\beta\rho_S^2)}{[(1-\rho_S)(1-\beta\rho_S)]^2} > 0$$

the external-balance component of the exchange-rate response is increasing in the perceived persistence of the tariff stance. □

A.3 Proof of Proposition 4

We derive the general-equilibrium decomposition of the real exchange-rate response to a transitory tariff shock. Start from the forward UIP under S-TPU in (18), and rewrite the international risk-sharing condition in (A.36) with the expected NFA path:

$$\sigma c_t = e_t^r + \psi\sum_{j\geq 0}\mathbb{E}_t b_{t+j} = (1-\nu)s_t - \nu\tau_t + \psi\sum_{j\geq 0}\mathbb{E}_t b_{t+j} \tag{A.43}$$

Substituting (A.43) into (A.35), and collecting terms as in (A.37), yields

$$y_t = \Omega_s s_t + \Omega_\tau \tau_t + \frac{1-\nu}{\sigma}\psi\sum_{j\geq 0}\mathbb{E}_t b_{t+j} \tag{A.44}$$

Under flexible prices, (A.43) and the labor-supply condition imply

$$y_t = -\frac{1}{\varphi}s_t - \frac{\psi}{\varphi}\sum_{j\geq 0}\mathbb{E}_t b_{t+j}$$

Combining this expression with (A.44) gives the S-TPU-modified version of the terms-of-trade condition in (A.38):

$$s_t = \underbrace{-A\tau_t}_{\substack{\text{static}\\ \text{effect}}} \underbrace{-\,\mathcal{H}\sum_{j\geq 0}\mathbb{E}_t b_{t+j},}_{\substack{\text{NFA-path}\\ \text{feedback}}} \qquad \mathcal{H} \equiv \frac{\psi\,(1+\varphi(1-\nu)/\sigma)}{1+\varphi\Omega_s} \tag{A.45}$$

Substituting (A.45) into (A.39) delivers

$$e_t^r = \Xi\tau_t - (1-\nu)\mathcal{H}\sum_{j\geq 0}\mathbb{E}_t b_{t+j} \tag{A.46}$$

It remains to close the expected NFA path. Using $\mathbb{E}_t\{\tau_{S,t}\} = \mathbb{K}(\sigma_S^2)\varepsilon_{T,t}$, and (A.42)

$$\sum_{j\geq 0}\mathbb{E}_t b_{t+j} = -\Gamma(\rho_S)\Lambda\mathbb{E}_t\{\tau_{S,t}\}$$

Substituting into (A.46) gives

$$e_t^r = \Xi\tau_t + \Phi^{GE}\mathbb{E}_t\{\tau_{S,t}\}, \qquad \Phi^{GE} = (1-\nu)\mathcal{H}\Lambda\Gamma(\rho_S)$$

Using the definitions of $\mathcal{H}$ and $\Gamma(\rho_S)$ delivers (32)-(33). $\square$

Online Appendix

Tariffs, Uncertainty, and the Exchange Rate

Alfonso Merendino and Tommaso Monacelli

Contents

B Empirical Appendix

B.1 Data

Below we provide more details on the data employed in the BVAR estimation.

Nominal and real effective exchange rate measures As the main effective exchange rate indicators, we consider the *nominal* and *real* effective exchange rate for the United States from the Bank for International Settlements (2026) (BIS), computed against a "narrow" basket of currencies composed of Australia, Austria, Belgium, Canada, Chinese Taipei, Denmark, the Euro area, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States.[35] These indices are designed to reflect developments in global trade by using time-varying weighting patterns[36] - expressed in monthly series, which we aggregate to quarterly frequency using simple averages and then transform into natural logs. For both the nominal and the real effective exchange rate, an increase corresponds to an appreciation.

Weighted-import tariff rate Our preferred trade-policy measure is the trade-weighted U.S. import tariff rate - we label it *WIT1*. Following the logic in Franconi and Hack (2025), we construct this series as the ratio of customs duties to dutiable imports. More precisely, customs duties are measured using FRED series *B235RC1Q027SBEA*. Dutiable imports are constructed as total goods imports from FRED series *A255RC1Q027SBEA* multiplied by the average share of dutiable goods in total imported goods, where the latter is computed using the U.S. International Trade Commission DataWeb. This construction implies that our series differs slightly from that in Schmitt-Grohé and Uribe (2025) - labeled *WIT2* - who instead computes the tariff rate as the ratio of U.S. import customs duties to the total value of goods imports. WIT1 measure has a simple interpretation: it captures the average tariff burden effectively applied to the subset of imports that is actually subject to duties. Compared with WIT2, based on total imports, this construction is better aligned with the actual incidence of tariffs, since it isolates the portion of trade flows

[35] For details, see `https://data.bis.org/topics/EER`

[36] The weights are derived from manufacturing trade flows and capture both direct bilateral trade and third-market competition through a double-weighting scheme. This trade-based weighting structure assumes that there is only one type of good, differentiated by country of origin, with a constant elasticity of substitution. Ideally, the weights are constructed so that a change in cross rates has no effect on a country's key macroeconomic aggregates as long as the real effective exchange rate remains constant.

on which duties are in fact levied.

Trade restrictiveness index (TRI) To complement the average tariff measure, we also use the Trade Restrictiveness Index (TRI) from Schmitt-Grohé and Uribe (2025), available at `https://www.columbia.edu/~mu2166/import_tariff/`. The TRI summarizes the overall restrictiveness of the tariff structure by combining information on tariff rates, import shares, and import demand elasticities into a single scalar measure. Let τ_{it} denote the ad valorem tariff on good i at time t, s_{it} the import share of good i, and ε_i the absolute value of the import demand elasticity. Following Schmitt-Grohé and Uribe, the welfare-equivalent uniform tariff, or Trade Restrictiveness Index, is defined as

$$\mathrm{TRI}_t = \left(\frac{\sum_i s_{it}\varepsilon_i \tau_{it}^2}{\sum_i s_{it}\varepsilon_i} \right)^{1/2}$$

Figure 1 compares the TRI with our benchmark weighted-import tariff measure and the alternative weighted-import tariff measure of Schmitt-Grohé and Uribe (2025) over the full post-1990 sample. Figure 2 zooms in on quarter-on-quarter changes around the narrative-event window.

Other data sources We summarize all the remaining data description in Table B.3. The displayed variables are obtained from FRED, maintained by the Federal Reserve Bank of St. Louis; identifiers are in italic letters.

B.2 Narrative evidence by event

In the main text, we identify tariff episodes that satisfy the three criteria in Section 2.3: narrative clarity (C1), a material movement in τ_t (C2), and sign consistency (C3). This appendix documents those episodes. We cover the two baseline events, 2018Q4 and 2025Q2, and the two additional events included in the extended set, 2019Q3 and 2019Q4.[37]

For each date, we rely, where relevant, on official records from (i) Federal Register notices, (ii) USTR releases, (iii) White House presidential actions, (iv) WTO records, and (v) European Commission records. We then corroborate the official record with contemporaneous coverage from major policy and financial news outlets (e.g., Reuters and The Wall Street Journal).

[37]The extended set includes more modest or goods-specific tariff measures. We therefore use these dates only in the robustness exercise reported in Online Appendix B.3.

Table B.3: Macroeconomic data

Variable	Data identifier and details
CPI inflation	*CPIAUCSL*. Percent change from year ago, seasonally adjusted. Quarterly data.
Real GDP	*GDPC1*. Levels in natural log, seasonally adjusted. Quarterly data.
Federal funds rate	*DFF*. Percent, not seasonally adjusted. Quarterly data.
Trade balance	Computed as $(EX - IM)/GDP \times 100$ using *GDPC1*, *IMPGSC1*, and *EXPGSC1*. Adjusted annual rate, seasonally adjusted, all in billions of chained 2017 dollars (seasonally adjusted, annual rate). Percent of real GDP. Quarterly data.
Terms of trade	*W371RG3Q020SBEA*. Price of export over import goods (nonpetroleum). Levels in natural log. Quarterly data.
EA real GDP	*CLV10MNACB1GQSCAEA20Q*. Chain-linked volumes (millions of euro), seasonally adjusted. Levels in natural log. Quarterly data.
EA CPI inflation	*I10_CPI*. Harmonised index of consumer prices, percent change from year ago. Monthly data aggregated to quarterly averages.
EA 3-month Euribor	*FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA*. Euribor 3-month, historical close, average of observations through period (ECB Data Portal). Percent. Monthly data aggregated to quarterly averages.

2018Q4: Section 301 List 3 Effective September 24, 2018, the USTR finalized the third Section 301 action against China, imposing an additional 10% *ad valorem* duty on approximately $200 billion of Chinese imports, (Office of the U.S. Trade Representative, 2018a,b) with duties being collected mostly in 2018Q4. List 3 was the central escalation of the bilateral tariff cycle initiated earlier that year. The WIT1 weighted tariff rate rises by 1.70 percentage points in 2018Q4, a move more than 1.8 standard deviations above the sample mean. Several newspapers reported the new tariff round[38], and the Guardian explicitly frames it as an escalation of the U.S.-China trade war[39].

Other tariff actions from the same U.S.-China trade-war cycle could also be considered as candidate shocks. In particular, two prominent actions occurred in 2018Q2: the initial Section 232 steel and aluminum tariffs and the original Section 301 determination. However, we do not classify 2018Q2 as a narrative shock because the realized increase in τ_t is small and does not correspond to a clear tariff

[38] Schlesinger and Salama, *The Wall Street Journal*, September 2018, `https://www.wsj.com/articles/trump-to-lay-out-line-on-china-trade-1537213209`

[39] Kuo and *Reuters*, *The Guardian*, September 2018, `https://www.theguardian.com/world/2018/sep/24/new-us-tariffs-on-china-take-effect-with-no-compromise-in-sight`

innovation. Nor does it appear to anticipate the larger tariff increase observed in 2018Q4.

2025Q2: "Liberation Day" On April 2, 2025, Executive Order 14257 imposed an additional *ad valorem* duty "on all imports from all trading partners," starting at a 10% baseline rate with country-specific reciprocal surcharges layered on top (Executive Office of the President, 2025). It is the broadest tariff increase in the postwar U.S. applying a baseline duty across trading partners and a wide range of products. The WIT1 weighted tariff rate rises unexpectedly by 9.31 percentage points in the quarter, around ten standard deviations above the sample mean. This event ignited worldwide fears of a trade war[40] and of a global economic recession[41]. The 2025Q2 observation is the main anchor of the baseline date set.

Other tariff actions around the same episode could also be considered as candidate shocks. In particular, the IEEPA tariffs on Chinese imports announced in February 2025 appear in 2025Q1. We do not classify 2025Q1 as a narrative shock because the realized increase in τ_t is modest relative to the April 2 package and does not represent an anticipation of the broader 2025Q2 "Liberation Day" tariff increase.

2019Q3: Section 301 List 4A Effective September 1, 2019, USTR modified the Section 301 action, raising the additional duty on approximately $112 billion of Chinese imports from 10% to 15% (Office of the U.S. Trade Representative, 2019a,c). List 4A extended coverage to essentially all remaining Chinese imports and completed the bilateral escalation begun in 2018[42]. The WIT1 weighted tariff rate rises by a considerable 1.26 percentage points in the quarter. Note that the measure is more modest than the broad-based tariff increases in the baseline set. We therefore do not treat 2019Q3 as a baseline narrative shock, but retain it in the extended date set.

2019Q4: WTO-authorized Airbus countermeasures Two distinct policy actions contribute to the 2019Q4 increase. In October 2019, the WTO Dispute Settlement Body authorized the United States to impose countermeasures on up to $7.5 billion of annual EU imports, in response to a finding of WTO-inconsistent subsidies

[40]French, *Reuters*, April 2025, https://www.reuters.com/markets/us/wall-street-futures-tailspin-tariffs-fuel-recession-fears-2025-04-03/

[41]Sweney, *The Guardian*, April 2025, https://www.theguardian.com/business/2025/apr/04/imf-warns-of-significant-risk-to-global-economy-from-trump-tariffs-as-markets-slide

[42]Mauldin and Deng, *The Wall Street Journal*, September 2019, https://www.wsj.com/articles/trump-administration-goes-ahead-with-new-tariffs-on-chinese-products-11567337797

to Airbus (Office of the U.S. Trade Representative, 2019b; European Commission, 2021). Acting on this, USTR imposed an additional 10% duty on large civil aircraft and a 25% duty on a range of agricultural and industrial EU products, effective October 18, 2019[43]. The Airbus countermeasures constitute a regional, dispute-specific tariff shock. Layered on top, 2019Q4 also captures the full-quarter incidence of the List 4A duties, whose September 1 effective date places only one month of new collections in Q3. Together the two actions raise the WIT1 weighted tariff rate by 1.39 percentage points in the quarter. The 2019Q4 observation enters the extended set as a joint narrative restriction reflecting the simultaneous incidence of a WTO-authorized regional countermeasure against the EU and the continuation of the Section 301 escalation against China.

B.3 Robustness of BVAR estimates to additional narrative dates

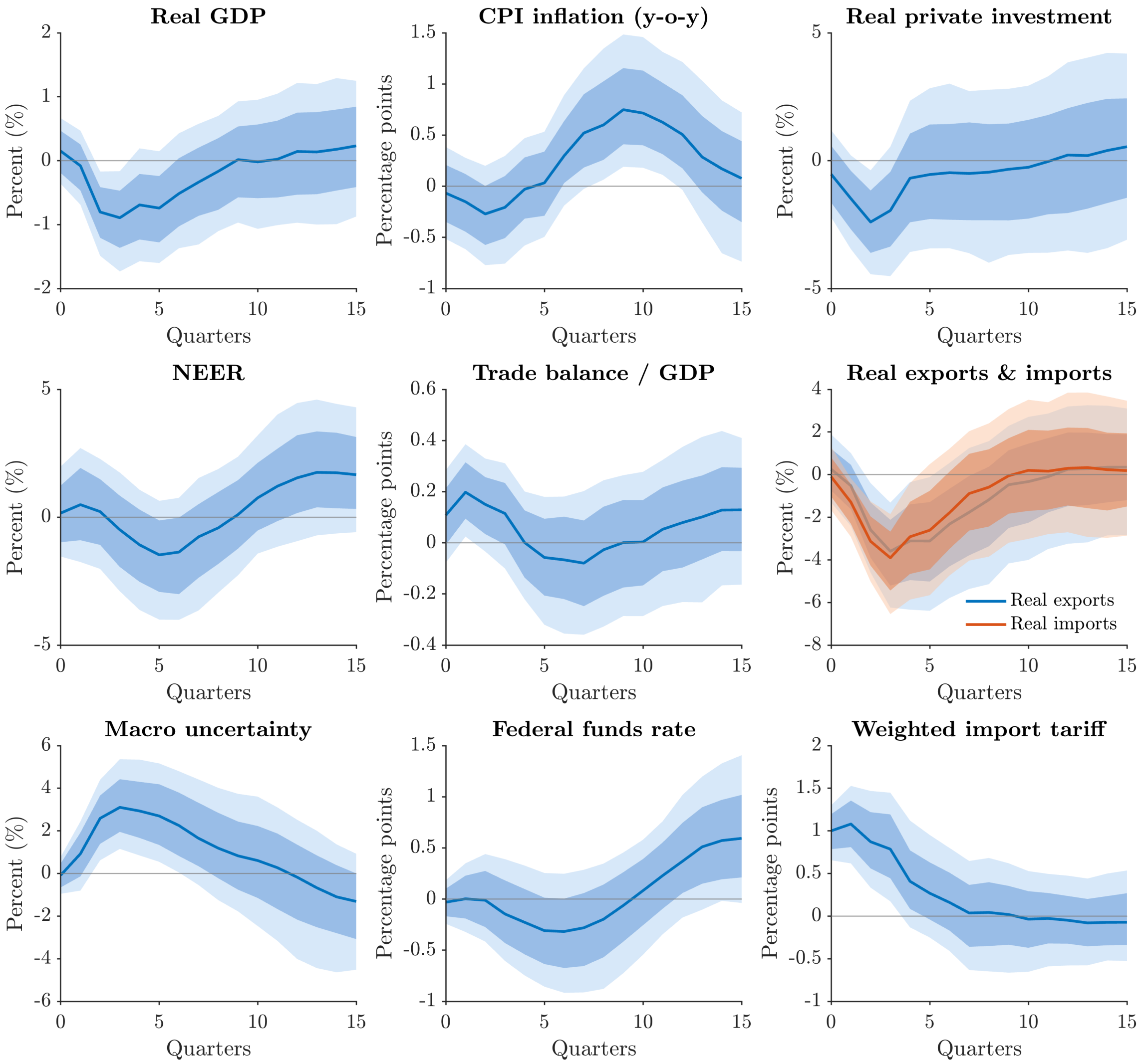
To assess whether our baseline findings depend on the particular choice of tariff event dates, this appendix section re-estimates the BVAR of Section 2 using an *extended* narrative approach. In addition to the baseline episodes, the extended set incorporates the 2019Q3 implementation of Section 301 List 4A tariffs and the 2019Q4 WTO-authorized countermeasures related to the Airbus dispute (see panel B of Table 1).[44]

Figures B.12 and B.13 report the estimated impulse responses of the NEER and the other macroeconomic variables for the long sample (1990Q1-2025Q2) and the short sample (2002Q1-2025Q2), respectively. Similarly, Figure B.14 presents the estimated impulse responses of the REER for the long and short samples. Across both specifications, the responses of the exchange rate and the other macroeconomic variables are quantitatively very similar to the baseline estimates, indicating that the main findings are robust to the inclusion of these additional tariff episodes.

[43] *Reuters*, October 2019, `https://www.reuters.com/article/wto-aircraft-usa/ustr-confirms-u-s-tariffs-to-hit-certain-eu-goods-on-oct-18-idUSL2N2722A4`

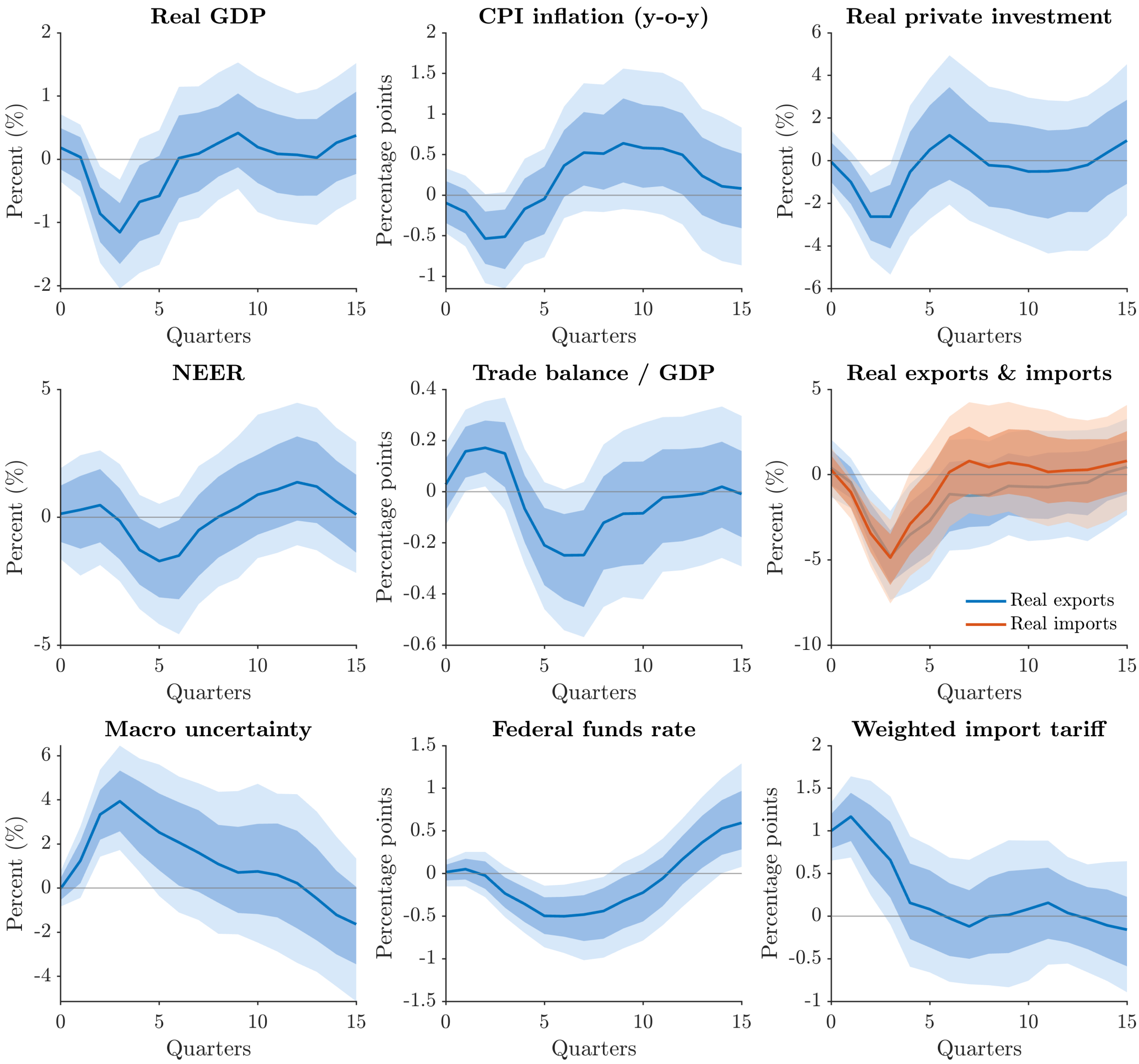
[44] Further details about the four narrative dates are provided in Appendix B.2.

Figure B.12: Estimated impulse responses of NEER and other macroeconomic variables to a 1 p.p. weighted-import tariff shock. A fall in the exchange rate is a depreciation.



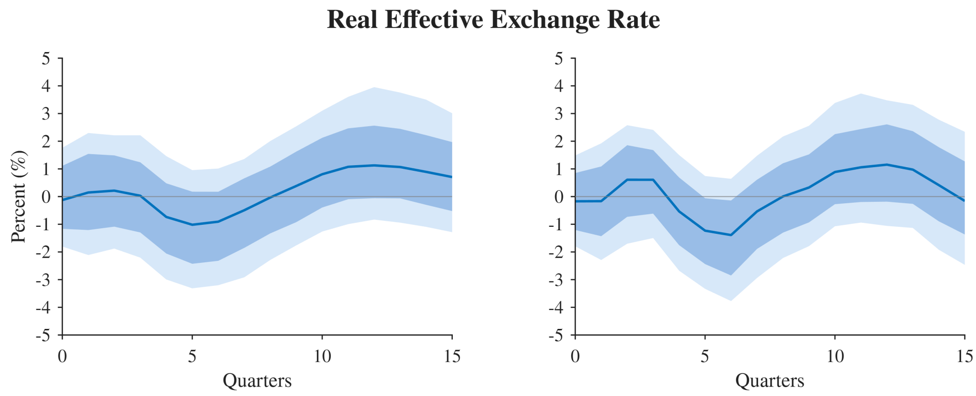
Notes: The sample considered covers U.S. indicators with quarterly frequency from 1990Q1 to 2025Q2. For more information, see the note to Figure 3.

Figure B.13: Estimated impulse response of NEER and other macroeconomic variables to a 1 p.p. weighted-import tariff shock. A fall in the exchange rate is a depreciation.



Notes: The sample considered covers U.S. indicators with quarterly frequency from 2002Q1 to 2025Q2. For more information, see the note to Figure 3.

Figure B.14: Estimated impulse responses of the real effective exchange rate (REER) to a 1 p.p. shock to the weighted import tariff. A fall in the exchange rate is a depreciation.



(a) 1990–2025 (b) 2002–2025

Notes: The figure shows the estimated impulse response of the real effective exchange rate (REER) to a 1 p.p. shock to the weighted import tariff. Panel (a) reports results for the 1990Q1-2025Q2 sample, while panel (b) reports results for the 2002Q1-2025Q2 sample. For further details, see the note to Figure 3. A fall in the exchange rate is a depreciation.

B.4 Measuring structural trade-policy uncertainty

We measure structural trade-policy uncertainty as the conditional volatility of innovations to the persistent component of U.S. trade policy. Observed tariffs combine movements in a persistent policy regime with transitory tariff wedges. The decomposition is not observed directly and is recovered from a state-space stochastic-volatility model for the tariff rate.

B.4.1 Model calibration

We calibrate the state-space model from Section 3.2.1 using the values in Table B.4.

The calibration assigns high persistence to the structural tariff (ρ_S) and low persistence to the transitory component (ρ_T). It also makes structural volatility smooth and persistent, through a lower η_S and a higher $\rho_{\sigma S}$, while allowing transitory volatility to absorb short-run abrupt movements through a higher η_T and a lower $\rho_{\sigma T}$. Identification of structural trade-policy uncertainty therefore comes from the maintained distinction between a slow-moving policy regime and a short-lived transitory tariff.[45]

[45] We assess the sensitivity of the filtered series to the persistence of the transitory blocks by re-estimating the model under (i) $\rho_T \in \{0.20, 0.30\}$ with $\rho_{\sigma,T} = 0.50$, (ii) $\rho_{\sigma,T} \in \{0.20, 0.30\}$ with

Table B.4: Stochastic-volatility model calibration

Symbol	Value	Description
ρ_S	0.975	Persistence of the structural component $\tau_{S,t}$
ρ_T	0.200	Persistence of the transitory component $\tau_{T,t}$
$\rho_{\sigma S}$	0.950	Persistence of structural log-volatility $\sigma_{S,t}$
$\rho_{\sigma T}$	0.500	Persistence of transitory log-volatility $\sigma_{T,t}$
η_S	0.250	Volatility of innovations to $\sigma_{S,t}$
η_T	0.900	Volatility of innovations to $\sigma_{T,t}$
$\bar{\sigma}_S$	-2.00	Long-run mean of structural log-SD
$\bar{\sigma}_T$	-2.00	Long-run mean of transitory log-SD

B.4.2 Model filtering

Given the calibrated parameters, we recover the latent states with a bootstrap particle filter applied to the standardized WIT1 tariff series. The procedure follows the particle-filtering logic of Born and Pfeifer (2014), adapted to the state-space stochastic-volatility system described above.

The filter uses the tariff rate as the only observation. At each date t, the algorithm works with a cloud of 100,000 particles, each representing a possible value of the unobserved state vector - the state vector contains the persistent tariff component and the two log-volatility states, $\{\tau_{S,t}, \sigma_{S,t}, \sigma_{T,t}\}$. For each particle, the tariff observation pins down the transitory component residually:

$$\tau_{T,t} = \tau_t - \tau_{S,t}. \tag{B.47}$$

Each particle is then weighted by the likelihood of the implied transitory tariff $\tau_{T,t}$ under its calibrated AR(1) law of motion. In particular, particles that imply transitory tariff movements consistent with the calibrated transitory process receive higher weight, while particles that imply unlikely movements receive lower weight. The weighted particle cloud is then systematically resampled in a bootstrap from 100,000 particles.

At each date t, the reported filtered state is the median across the resampled particle cloud, following the convention in the Born and Pfeifer (2014) routines. Let $\widehat{\sigma}_{S,t|t}$ and $\widehat{\sigma}_{T,t|t}$ denote the filtered median estimates of the structural and transitory tariff log-volatilities, respectively. We define structural trade-policy uncertainty as the corresponding filtered variance estimate for innovations to the persistent tariff

$\rho_T = 0.50$, and (iii) both lowered jointly to $\{0.20, 0.20\}$ and $\{0.30, 0.30\}$. The identified peaks in the estimated S-TPU series are qualitatively unvaried.

component:

$$STPU_t = \exp\big(2\widehat{\sigma}_{S,t|t}\big)\,. \tag{B.48}$$

Because the particle filter is run on the standardized tariff series, this variance is converted back to tariff-level units by multiplying it by the squared standard deviation of WIT1 over the filtering window.

B.5 State-dependent local projections

This Appendix section complements the state-dependent evidence in the main text with the operational details of the local-projection exercise. We estimate state-dependent local projections (Jordà (2005), Ramey and Zubairy (2018)) of the macroeconomic variables on a series of narrative-identified tariff shocks, conditioning on the regime of structural trade-policy-uncertainty (S-TPU).

The regressor that enters the local projection is the structural tariff shock ε_t^τ identified by the Bayesian-VAR of Section 2. The series we feed into the local projection is the identified structural innovation

$$\varepsilon_t^\tau \;=\; \big[A_0\,u_t\big]_1 \qquad u_t \;=\; y_t - \widehat{c} - \textstyle\sum_{j=1}^{p} \widehat{A}_j\, y_{t-j} \tag{B.49}$$

where $A_0 = B^{-1}$ is the structural impact matrix and u_t the reduced-form innovation.

Following Section 3.3, let $H_t = \mathbf{1}\{STPU_t > p_{70}\}$ denote the high-uncertainty indicator and ε_t^τ the narrative tariff shock, for each horizon $h = 0, \ldots, 6$ and response variable y_t we estimate

$$y_{t+h} \;=\; \alpha_h \;+\; \beta_h\,\varepsilon_t^\tau \;+\; \beta_h^H\,H_t\,\varepsilon_t^\tau \;+\; \delta_h\,H_t \;+\; \sum_{j=1}^{4} \gamma_{j,h}\,y_{t-j} \;+\; u_{t+h} \tag{B.50}$$

with four lags of the dependent variable, an LP intercept α_h, and a state-level component $\delta_h H_t$ that absorbs the direct effect of the high-uncertainty regime on the level of y_{t+h}. With this control, β_h identifies the response in the low-uncertainty regime ($H_t = 0$) and $\beta_h + \beta_h^H$ the response in the high-uncertainty regime ($H_t = 1$, the top 30% of the distribution in the baseline).

The shock ε_t^τ entering (B.50) is estimated in the first-stage BVAR, which delivers not a single shock series but a whole set of N_d admissible ones (one for each accepted posterior draw and rotation). Running the projection on a single series and reporting its LP standard errors would treat the shock as known data and thereby understate the true uncertainty (the generated-regressor problem of Pagan (1984)). The neglected uncertainty has two sources: posterior uncertainty about the reduced-form parameters $(A_1, \ldots, A_p, c, \Sigma_u)$, and set-identification uncertainty about the rotation Q that maps them into the structural shock.

We carry both sources into the projection by re-estimating (B.50) on every admissible draw d, using that draw's own shock series. From each run, we obtain the per-draw point estimate $\widehat{\Theta}_h(d)$ of the impulse-response coefficient together with its Newey–West HAC sampling variance $V_h(d)$.[46] We represent each draw's within-draw sampling distribution by Gaussian simulation, drawing S values

$$\widetilde{\Theta}_h^{(d,s)} \sim \mathcal{N}\big(\widehat{\Theta}_h(d),\, V_h(d)\big), \qquad s = 1, \ldots, S$$

independently across (d, s). Pooling the $(N_d \times S)$ realisations $\{\widetilde{\Theta}_h^{(d,s)}\}$ yields, for each horizon h and S-TPU state, a single predictive distribution whose dispersion realises the law of total variance,

$$\underbrace{\mathrm{Var}\big(\widetilde{\Theta}_h\big)}_{\text{total}} = \underbrace{\mathrm{Var}_d\big(\mathbb{E}[\widetilde{\Theta}_h \mid d]\big)}_{\text{between: identification}} + \underbrace{\mathbb{E}_d\big(\mathrm{Var}[\widetilde{\Theta}_h \mid d]\big)}_{\text{within: LP sampling}}. \tag{B.51}$$

The plotted line is the median-shock point estimate $\widehat{\Theta}_h^{\star}$, obtained by re-estimating (B.50) once on the across-draw median of the identified shock series. The shaded 68% and 90% bands are Hall-recentered quantiles of the pooled predictive distribution: each quantile q_α of $\{\widetilde{\Theta}_h^{(d,s)}\}$ is shifted by $\widehat{\Theta}_h^{\star} - \mathrm{med}\{\widetilde{\Theta}_h^{(d,s)}\}$, so that the recentered band median coincides with $\widehat{\Theta}_h^{\star}$ while the bands inherit the asymmetry of the pooled distribution.

All responses are expressed per 1 p.p. impact on the weighted import tariff: we divide every per-draw impulse response by the same denominator, the impact tariff response of the median-shock projection, which puts all draws on one comparable footing, discards no draw, and avoids the ratio-distribution blow-up that arises when a draw's own on-impact response is near zero.

One assumption deserves emphasis. The tariff shock is identified from a single, linear BVAR whose coefficients and impact matrix are constant over the sample, yet the local projection lets its transmission differ across S-TPU regimes. We are thus assuming that the identification and on-impact propagation of the shock do not themselves depend on the regime, even though its dynamic effects do. A fully nonlinear treatment, in the spirit of the regime-dependent (smooth transition) VAR of Caggiano et al. (2014), in which shocks are identified and propagated within each state, would relax this assumption. However, this specification would come at

[46] Standard errors are computed with Newey–West corrections, allowing for serial correlation over the horizon of the local projection. We set the truncation lag equal to the horizon, $L = h$.

the cost of tractability and transparency. We therefore retain the simpler two-step design, as is standard in the state-dependent LP literature, and read the estimates as regime-specific responses to a common, linearly identified shock.

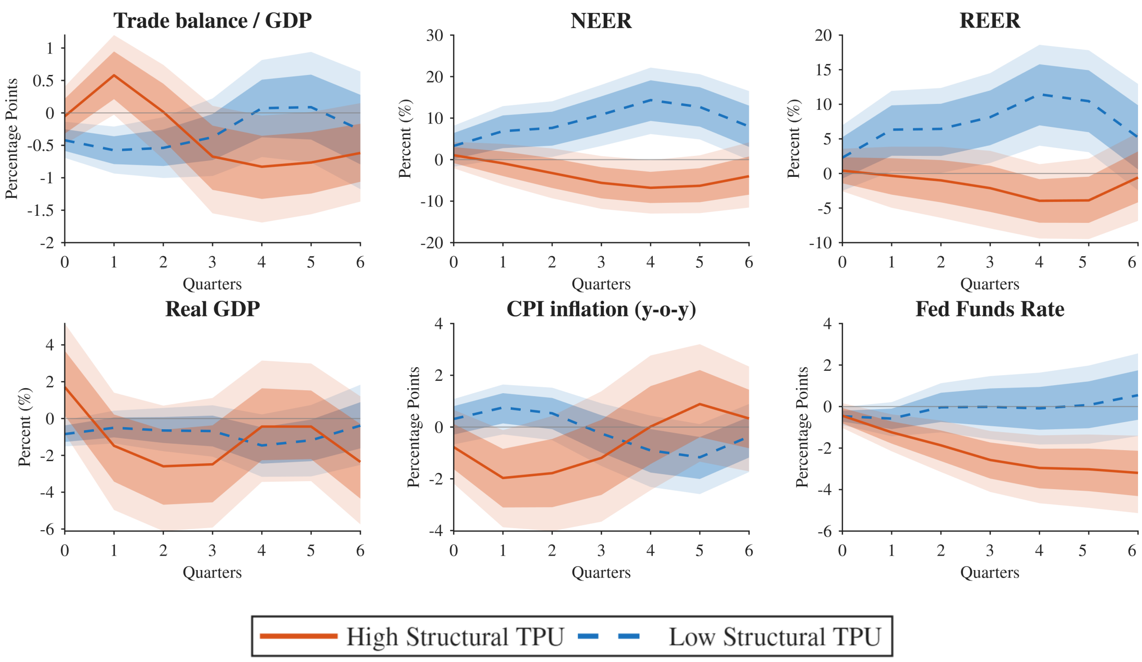
B.5.1 Robustness of state-dependent estimates

We assess whether the state-dependent responses depend on the cutoff used to define the high-$STPU_t$ state. We re-estimate (5) using three alternative cutoffs: the top 40%, 20%, and 10% of the $STPU_t$ distribution.[47] Formally, for $q \in \{60, 80, 90\}$, we define

$$H_t^{(q)} = \mathbf{1}\{STPU_t > p_q\},$$

and replace H_t in (5) with $H_t^{(q)}$. Figures B.15, B.16, and B.17 report the corresponding results. The state dependence of the responses is robust across the alternative cutoffs.

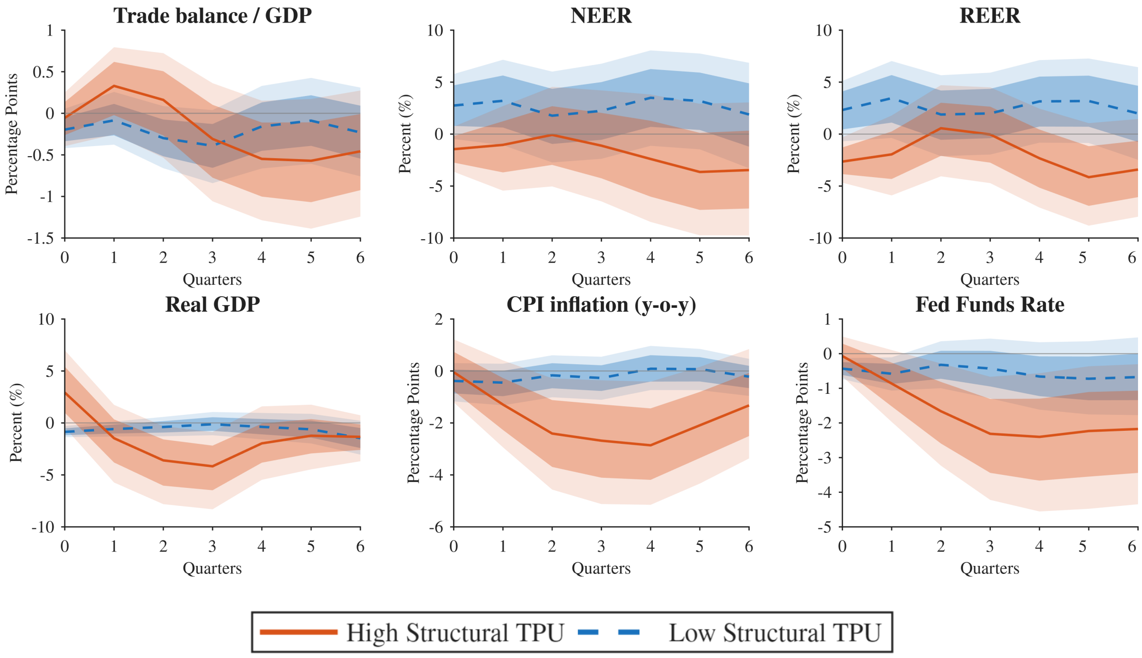
Figure B.15: State-dependent impulse responses: high S-TPU state in the top 40%



Notes: For details, see Figure 10.

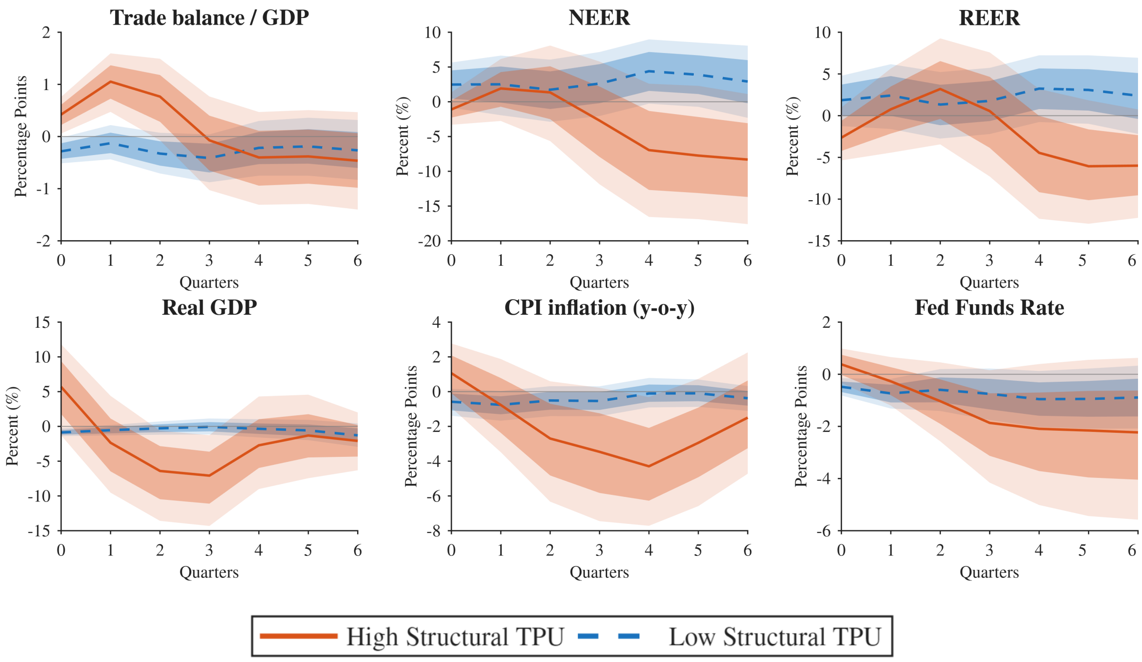
[47]See Figure 10 and the corresponding notes for details on the baseline specification, variables, shock normalization, and construction of the confidence bands.

Figure B.16: State-dependent impulse responses: high S-TPU state in the top 20%



Notes: For details, see Figure 10.

Figure B.17: State-dependent impulse responses: high S-TPU state in the top 10%



Notes: For details, see Figure 10.

C Model Appendix

In the main text section 4.4, we represent the tariff-learning problem as a signal-extraction problem. Agents observe the current tariff, or equivalently the surprise in the tariff signal relative to their prior forecast, but not its decomposition into a persistent tariff and an *i.i.d.* disturbance. The purpose of this appendix is to state that learning problem formally, describe the associated Bayesian updating, and derive the steady-state Kalman gain that governs belief revision in the main text.

C.1 Details on the state-space model

We begin from a general state-space representation of the pair *persistent tariff, observed tariff*. The persistent tariff evolves as a Markov process, while the tariff currently observed depends on that latent state through an observation equation.

Assumption C.1 (Persistent tariff as a Markov process)**.** *At time t, the sequence of persistent tariff $\{\tau_{S,t}\}_{t\geq 0}$ is a Markov process in $\mathbb{R}$, following the motion law*

$$\tau_{S,t} \sim \mathcal{P}_{\tau_S}(\cdot \mid \tau_{S,t-1}).$$

The transition probability satisfies

$$\mathcal{P}_{\tau_S}(\cdot \mid \tau_{S,0:t-1}) = \mathcal{P}_{\tau_S}(\cdot \mid \tau_{S,t-1})\,.$$

Assumption C.2 (Conditional independence of the observed tariff)**.** *Conditionally on the sequence $\{\tau_{S,t}\}_{t\geq 0}$, the observed tariffs $\{\tau_t\}_{t\geq 0}$ are independent, and τ_t depends on $\tau_{S,t}$ only. Let the conditional probability measure of observed tariffs be $\mathcal{P}_{\tau|\tau_S}(\cdot \mid \tau_{S,t})$. The observed tariff measure is $\mathcal{P}_\tau(\cdot) = \int_{\mathbb{R}} \mathcal{P}_{\tau|\tau_S}(\cdot \mid \tau_{S,t})\; d\mathcal{P}_{\tau_S}(\cdot)$*

The generic state-space representation can then be written as

$$\begin{aligned} \tau_{S,t} &\sim \mathcal{P}_{\tau_S}(d\tau_{S,t} \mid \tau_{S,t-1}) \\ \tau_t &\sim \mathcal{P}_\tau(d\tau_t \mid \tau_{S,t}) \end{aligned} \tag{C.52}$$

In the linear-Gaussian specification used in the paper, the above system specializes to system (27) in the main text.

C.2 Bayesian learning

This appendix provides the formal Bayesian foundation for the Bayesian split equation (29) in the main text. Agents know the state-space system (27), hold a prior over the initial persistent tariff, and learn from the history $\{\tau_t\}_{t\geq 0}$. The learning problem is summarized by two recursively updated objects.

The filtering distribution $\mathcal{P}_{\tau_{S,t}}(d\tau_{S,t} \mid \tau_{0:t})$ gives the distribution of the current persistent tariff conditional on observed tariffs. Given the predictive prior $\mathcal{P}_{S,t-1}(d\tau_{S,t} \mid \tau_{0:t-1})$, it satisfies Bayes' rule,

$$\mathcal{P}_{\tau_{S,t}}(d\tau_{S,t} \mid \tau_{0:t}) \propto \mathcal{P}_{\tau}(d\tau_t \mid \tau_{S,t}) \cdot \mathcal{P}_{\tau_{S,t-1}}(d\tau_{S,t} \mid \tau_{0:t-1}) \tag{C.53}$$

The state-predictive distribution is obtained by integrating the state equation against the current filtering distribution,

$$\mathcal{P}_{\tau_{S,t}}(d\tau_{S,t+1} \mid \tau_{0:t}) = \int_{\mathbb{R}} \mathcal{P}_{\tau_S}(d\tau_{S,t} \mid \tau_{S,t}) \cdot \mathcal{P}_{\tau_{S,t}}(d\tau_{S,t} \mid \tau_{0:t}) \tag{C.54}$$

and becomes the prior for the filtering step at $t+1$.

Under the linear-Gaussian system (27), the two conditional means $\mathbb{E}_t\{\tau_{S,t}\}$ and $\mathbb{E}_{t-1}\{\tau_{S,t}\}$ are sufficient statistics of the filtering and the predictive prior distributions. By the standard Kalman formulae,[48] we have the evolution of the posterior:

$$\underbrace{\mathbb{E}_t\{\tau_{S,t}\}}_{\text{posterior estimate}} = \underbrace{\mathbb{E}_{t-1}\{\tau_{S,t}\}}_{\text{prior forecast}} + \underbrace{\mathbb{K}(\sigma_S^2)}_{\text{Kalman gain}} \underbrace{(\tau_t - \mathbb{E}_{t-1}\{\tau_{S,t}\})}_{\zeta_t\text{: tariff surprise}} \tag{C.55}$$

With some algebra, we can rewrite equation (C.55) into the Bayesian split in (29).

C.3 Steady-state Kalman gain

The Kalman gain $\mathbb{K}(\sigma_S^2)$ is treated as constant in the main text. This assumption requires some context. The gain measures the weight the filter places on the current tariff observation τ_t when updating beliefs about the unobserved persistent stance $\tau_{S,t}$. Because learning occurs in a dynamic environment, the gain is generally time-varying: each new observation reduces uncertainty about the latent stance, while the state equation reintroduces uncertainty through the innovation variance σ_S^2. The constant gain used in the paper is therefore the steady-state value at which these two forces balance.

Let W denote the steady-state one-step-ahead prediction variance of the persis-

[48] See Petris et al. (2009) for a detailed reference.

tent component. With the transitory disturbance variance normalized to one, the steady-state gain is

$$\mathbb{K}(\sigma_S^2) = \frac{W}{1+W}$$

where W solves the steady-state Riccati equation

$$W = \frac{\rho_S^2 W}{1+W} + \sigma_S^2$$

The gain is increasing in σ_S^2. A higher innovation variance of the persistent stance raises the prediction variance W, making the prior less precise. The filter therefore places more weight on the current tariff observation. Implicit differentiation of the Riccati equation gives

$$\frac{\mathrm{d}W}{\mathrm{d}\sigma_S^2} = \frac{W+1}{2W+1-\rho_S^2-\sigma_S^2} > 0, \qquad \frac{\mathrm{d}\mathbb{K}(\sigma_S^2)}{\mathrm{d}\sigma_S^2} = \frac{1}{(W+1)^2}\frac{\mathrm{d}W}{\mathrm{d}\sigma_S^2} > 0.$$

The existence of a positive stabilizing solution W guarantees that the filter admits a steady state. A sufficient condition for asymptotic stability of the steady-state Kalman filter is

$$\rho_S \left(1 - \mathbb{K}(\sigma_S^2)\right) < 1.$$

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