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Working Paper (WP/26-05)

Inflation Dynamics under Global Supply Chain Disruptions in a Small Open Economy: The Role of Trade Vulnerability, Shock Volatility, and Monetary Policy Stance

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July 2026

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Inflation Dynamics under Global Supply Chain Disruptions in a Small Open Economy: The Role of Trade Vulnerability, Shock Volatility, and Monetary Policy Stance

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Abstract

This paper examines the transmission of global supply-chain disruptions to inflation in small open economies, focusing on the joint roles of trade vulnerability, shock volatility, and monetary policy stance. Using panel local projections for ASEAN-5 economies, we find that inflation responses to global supply-chain pressure shocks display a delayed, hump-shaped profile. The point estimates suggest stronger responses in economies with greater trade vulnerability and more persistent effects during high-volatility episodes, while trade openness on its own does not systematically amplify pass-through. To interpret these findings, we develop a nonlinear two-country New Keynesian DSGE model calibrated to Indonesia, featuring an imported-input cost channel, regime-switching external shock volatility, and hawkish-dovish monetary policy regimes. The model provides a structural mechanism consistent with the empirical patterns: high trade vulnerability and high shock volatility magnify imported-cost pass-through, while a weaker monetary-policy response allows inflationary pressures to become more persistent. A stronger monetary-policy response dampens inflation and marginal-cost persistence, but does not fully offset the contractionary effects of supply-chain disruptions when vulnerability is high. The results highlight the importance of structural resilience and responsive monetary policy in mitigating external inflation risks.

Keywords: Global supply chains; Inflation dynamics; Trade vulnerability; Regime-switching DSGE models; Local projections; Monetary policy stance.
JEL Classification: E31, E32, E52, F41, F62.

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[2]I sincerely thank Jongrim Ha, Xianguo Huang, Takeki Sunakawa, and Giorgio Valente (at the 2026 AFTN seminar in Tokyo) for their constructive comments. The views expressed in this paper are the author's and do not necessarily represent those of AMRO or AMRO management. All errors remain the author's.

Contents

1 Introduction

Recent global events have highlighted the macroeconomic importance of supply-chain disruptions. The COVID-19 pandemic, shipping bottlenecks, geopolitical tensions, and shifts in global logistics conditions have generated substantial volatility in global supply conditions and production networks (Benigno et al., 2022; di Giovanni et al., 2022). These disruptions have been associated with heightened inflationary pressures across advanced and emerging economies, raising concerns about how external supply shocks propagate to domestic prices and economic activity (Gordon and Clark, 2023; Finck and Tillmann, 2023; Acharya et al., 2023). For ASEAN-5 economies, this issue is particularly important. The region is deeply integrated into global production networks and relies heavily on imported intermediate goods, external demand, and maritime logistics. Moreover, recent research shows that global supply chain disruptions have had uneven macroeconomic impacts across ASEAN+3 economies, reflecting differences in exposure to transportation service shortages and supply-chain linkages during the pandemic (Tang, 2022).

This paper studies how global supply-chain pressure (GSCP) shocks are transmitted to inflation in small open economies and examines why the pass-through of these shocks may differ across countries and monetary policy regimes. The central argument is that the inflationary effects of GSCP shocks depend not only on trade openness/intensity, but also on structural trade vulnerability, the volatility of global supply conditions, and the stance of monetary policy. Trade openness captures the scale of external exposure, but it does not fully describe imported-input dependence and production-network fragility. Monetary policy responses are also inherently difficult because supply-chain shocks raise inflation while weakening real activity. Empirically, the analysis uses panel local projections (LP) for ASEAN-5 economies, while the structural mechanism is examined using a nonlinear two-country New Keynesian dynamic stochastic general equilibrium (DSGE) model calibrated to the Indonesian economy and featuring Markov-switching shock volatility and hawkish-dovish monetary policy regimes.

The distinction between trade intensity and structural vulnerability is central to recent inflation dynamics. While more open economies are mechanically exposed to external developments, recent evidence suggests that global supply-chain disruptions contributed materially to post-pandemic inflation dynamics beyond aggregate demand factors (Gordon and Clark, 2023). The transmission of these shocks depends not only on the volume of trade but also on production-network characteristics, including reliance on imported intermediate inputs, sectoral input-output linkages, supplier concentration, and logistical constraints (di Giovanni et al., 2022). When firms face higher imported input costs and supply constraints, they pass through part of these costs to consumers, amplifying inflationary pressures–a pattern documented across both European economies (Binici et al., 2024) and the broader post-pandemic episode (Gordon and Clark, 2023). These considerations imply that vulnerability to GSCP shocks reflects deeper structural characteristics than trade openness, a distinction relevant for interpreting inflation dynamics in open economies and for designing appropriate macroeconomic policy responses.

GSCP shocks also pose a difficult challenge for monetary policy. Unlike conventional demand shocks, these disruptions raise inflation by increasing production and import costs while simultaneously weakening real economic activity. Central banks therefore face a trade-off between looking through supply-driven inflation to avoid reinforcing the downturn and tightening policy to prevent second-round effects and a de-anchoring of inflation expectations. This trade-off is in line with mainstream monetary theory, which prescribes a stronger response to demand-driven inflation but a more muted response to supply-driven inflation when expectations remain anchored (Erceg et al., 2000; Bodenstein et al., 2008), and with recent policy-oriented evidence that monetary policy responses differ depending on whether inflation is driven by supply or demand factors (Hofmann et al., 2024). Recent work further shows that global supply-chain pressures can generate persistent inflationary effects and complicate monetary-policy decisions, especially when supply-chain stress is elevated (Andriantomanga et al., 2023; Hernández et al., 2024). More generally, uncertainty about the persistence and transmission of supply-chain shocks can justify cautious policy adjustment (Brainard, 1967; Bernanke, 2004). In this context, hawkish and dovish monetary-policy regimes are used as counterfactual policy stances to examine how the strength of the inflation response conditions GSCP shock transmission, rather than as a normative ranking of policy choices.

Existing studies have examined the aggregate inflationary effects of supply-chain disruptions in advanced and European economies (Gordon and Clark, 2023; Acharya et al., 2023) and across ASEAN+3 (Tang, 2022), but the joint role of structural trade vulnerability and global volatility regimes in shaping pass-through has not been systematically examined, especially for ASEAN-5 economies. In addition, the interaction between these external factors and the stance of monetary policy–that is, the strength of the policy response to inflationary pressures under supply-side disruptions–has received limited attention. Rather than focusing on trade fragmentation, decoupling, or tariff shocks, the analysis centers on GSCP shocks that capture disruptions in shipping costs, logistics bottlenecks, and international production networks, proxied using the Global Supply Chain Pressure Index (GSCPI) of Benigno et al. (2022). The key contribution of this paper, therefore, is not that each model component is individually new, but that the paper integrates several mechanisms that are usually studied separately: imported-input cost pass-through, time-varying trade vulnerability, regime-switching GSCP volatility, and state-dependent monetary policy. By linking these mechanisms to the LP evidence, the analysis provides a unified account of why similar external supply-chain shocks can generate different inflation responses across economies and volatility regimes.

To characterize cross-country exposure to such GSCP disruptions, we incorporate measures of trade openness alongside a Global Trade Vulnerability Index (GTVI), constructed using a time-varying parameter factor-augmented VAR (TVP-FAVAR) with stochastic volatility following Koop and Korobilis (2013). The index reflects structural dependence on imported intermediate inputs, trade linkages, and external cost sensitivity. These variables are combined with macroeconomic time series–including inflation, exchange rates, import prices, and global cost indicators, with output gaps and policy variables added in richer specifications–to estimate inflation impulse responses to GSCP shocks. For the empirical analysis, local-projection (LP) approach of Jordà (2005) is particularly suitable because it allows flexible estimation of dynamic responses without imposing strong structural restrictions; interaction terms and regime-specific analysis can be readily incorporated within this framework. Specifically, the empirical specification allows the inflationary effects of GSCP shocks to vary across high- and low-volatility regimes.

The empirical analysis suggests three main findings. GSCP shocks generate hump-shaped inflation responses, with peak effects occurring after roughly three to five quarters. Trade openness on its own does not systematically amplify pass-through once structural vulnerability and macroeconomic controls are included. Furthermore, inflation responses appear more persistent during high-volatility periods, and the point estimates suggest stronger effects in structurally exposed economies. These findings motivate the structural model developed in the second part of the paper, where the transmission mechanism is examined through imported-input cost channels, regime-switching shock volatility, and hawkish-dovish monetary policy regimes.

The second component of this paper develops a two-country New Keynesian DSGE model to provide a structural interpretation of the empirical findings. The model is calibrated to the Indonesian economy and incorporates regime-switching GSCP shock volatility and state-dependent monetary policy, allowing the transmission of global supply disruptions to vary with both external uncertainty and the strength of the monetary policy response. A GSCP-driven shipping-cost wedge raises import prices and enters firms' marginal costs through an imported-input cost channel, while exchange-rate dynamics are captured by a uncovered interest parity-type (UIP) specification with a persistent risk premium. Trade openness operates through import intensity and external leakage, shaping quantitative exposure to foreign inputs, whereas a vulnerability parameter governs the pass-through of global supply disruptions into domestic marginal costs. GSCP shocks are specified as persistent disturbances whose volatility switches between low- and high-volatility states according to a two-state Markov chain. Monetary policy, in turn, can shift between hawkish and dovish stances, capturing counterfactual differences in the strength and timing of policy responses to inflationary pressures. This joint structure allows the model to examine how policy stance affects the persistence of imported-cost pass-through when high external volatility coincides with elevated trade vulnerability. The resulting dynamics should be interpreted as illustrating stabilization trade-offs under external supply shocks, rather than as implying that one policy stance is unconditionally preferable.

By integrating the empirical LP evidence with structural DSGE simulations, the analysis provides a complementary account of how global supply-chain disruptions propagate through production costs, monetary policy responses, and external adjustment channels. The LP results indicate that inflationary spillovers depend not simply on trade openness, but also on structural vulnerability and the volatility regime of global supply conditions. The DSGE simulations extend this interpretation by showing how imported-input cost pass-through and monetary policy stance shape the propagation of these shocks. This perspective offers a plausible account of why similar degrees of trade openness can be associated with markedly different inflation outcomes across economies, and highlights the joint importance of supply-chain resilience and monetary-policy trade-offs in managing external inflation risks. In particular, the structural results suggest that a stronger policy response may dampen inflation persistence, but cannot directly resolve imported-input disruptions and may involve real-activity costs.

The remainder of the paper is structured as follows. Section 2 presents the LP framework and empirical results. Section 3 develops the DSGE model and discusses the model-based impulse responses used to interpret the empirical transmission mechanisms. Section 4 concludes.

2 Empirical Model and Results

The empirical analysis draws on quarterly panel data for the ASEAN-5 economies–Indonesia, Malaysia, the Philippines, Thailand, and Singapore–spanning Q1 2008 to Q2 2025, sourced from CEIC. The sample period captures several major episodes of external and supply-chain stress, including the broad-based global contraction of 2008-2009, the COVID-19 pandemic disruptions of 2020-2021, and the post-pandemic shipping bottlenecks of 2021-2022, providing variation across both high- and low-volatility episodes. The analysis examines how inflation responds to unexpected global trade-disruption shocks, with particular attention to two transmission channels emphasized in the structural model: trade openness as a potential scale-of-exposure or leakage channel, and trade vulnerability as a factor that may amplify the inflationary impact of global supply-chain disturbances. The empirical strategy relies on the panel LP framework of Jordà (2005), which provides flexible horizon-specific impulse responses without imposing strong restrictions on the underlying data-generating process and accommodates heterogeneity in transmission through interaction terms and regime-specific specifications. The limited number of economies and the relatively short subsample within each regime nonetheless warrant caution in interpreting the regime-specific estimates.

2.1 Interpreting trade vulnerability

A key distinction in the empirical analysis is between trade openness and trade vulnerability. Trade openness captures the scale of external transactions relative to domestic activity, while the GTVI is intended to capture the sensitivity of an economy to global trade and supply-chain disruptions. Openness may be one source of vulnerability, since greater external exposure can increase the channels through which global shocks affect domestic prices. However, openness does not fully determine vulnerability. The inflationary pass-through from GSCP shocks also depends on the composition of trade, imported-input dependence, production-network linkages, supplier concentration, external cost sensitivity, and logistics-related frictions. This distinction matters because economies with similar degrees of openness may differ substantially in their vulnerability to global supply-chain disruptions. For example, a highly open economy whose trade is concentrated in re-export or services activities may not face the same imported-input cost sensitivity as an economy more deeply embedded in manufacturing production networks. Similarly, a less open economy may still be vulnerable if key sectors rely heavily on imported intermediate inputs, specialized suppliers, or logistics-sensitive production networks. The GTVI is therefore interpreted as a broader time-varying vulnerability measure, rather than as a fixed structural characteristic equivalent to trade openness.

Table 2 in the appendix provides additional diagnostics on the time-series behavior of the GTVI across ASEAN-5 economies. The table reports rolling volatility, the frequency and duration of extreme observations, and AR(1)-based persistence measures. The diagnostics show that vulnerability dynamics differ substantially across countries. Indonesia and Singapore display the highest average rolling volatility, suggesting more variable short-run movements in the vulnerability index. Thailand and Malaysia show lower volatility but more moderate persistence, while the Philippines stands out for its high persistence and the longest run of extreme observations. This suggests that vulnerability in the Philippines behaves less like a purely mean-reverting fluctuation and more like a persistent movement over the sample period. These patterns support treating GTVI as a predetermined, time-varying vulnerability measure, while cautioning against interpreting it as a time-invariant openness-type measure. For the DSGE analysis, these empirical dynamics are not modeled as a separate stochastic vulnerability process; instead, they are summarized through alternative values of the vulnerability parameter, which governs the pass-through of GSCP shocks into import prices and marginal costs.

Appendix Table 3 provides diagnostic correlations between GTVI, trade openness, the GSCPI, the estimated standardized GSCP shock, and rolling GSCPI volatility. The pooled correlation between GTVI and trade openness is close to zero, both in raw terms and after removing country-specific means. The finding suggests that the vulnerability index is not simply a relabeled measure of trade intensity. At the country level, the relationship between GTVI and openness is heterogeneous. The Philippines displays a positive correlation between GTVI and openness, while Malaysia records a negative correlation and the remaining economies show relatively weak correlations. This heterogeneity supports the distinction between the scale of trade and the structure of vulnerability.

The table also helps clarify whether GTVI overlaps mechanically with global supply-chain stress. GTVI is moderately correlated with the GSCPI level and with rolling GSCPI volatility, which is not surprising as the index is time varying and partly captures periods of heightened external fragility. However, the correlations are not sufficiently high to suggest that GTVI is equivalent to global supply-chain stress or to the volatility regime itself. More importantly, the correlation between GTVI and the estimated standardized GSCP shock is close to zero in the pooled sample, both before and after removing country-specific means. This indicates that the GTVI interaction is not mechanically driven by the shock series used in the LP estimation.

These diagnostics support interpreting GTVI as a predetermined, time-varying vulnerability measure: it is not a fixed country characteristic equivalent to trade openness, nor is it simply a proxy for the GSCP shock itself, although it may partly reflect periods of heightened external fragility. The interaction term therefore captures whether the inflationary effect of a given GSCP shock is larger when an economy is more vulnerable to external supply-chain disruptions. Since GTVI varies over time and is moderately related to global supply-chain conditions, the interaction should not be interpreted as reflecting only fixed cross-country structural heterogeneity. Rather, it captures vulnerability-dependent pass-through that may evolve with external fragility, production-network conditions, and logistics-related pressures. For this reason, the heterogeneity results associated with the GTVI interaction are interpreted as suggestive evidence of vulnerability-dependent amplification rather than as definitive causal estimates of a fixed structural parameter.

Motivated by this interpretation, the LP specification includes both trade openness and GTVI, as well as their interactions with GSCP shocks, allowing the inflation response to vary separately with trade intensity and time-varying trade vulnerability.

2.2 Local projections (LP) specification

Let i index countries, $t$denote time, and $h = 0, 1, \ldots, H$ the forecast horizon, the baseline local projection specification is

$$\pi_{i,t+h} - \pi_{i,t-1} = \alpha_h + \beta_{h,0} z_t^{\text{gscp}} + \beta_{h,1} TO_{i,t-1} + \beta_{h,2} GTVI_{i,t-1}^{TVP} \ldots \\ + \beta_{h,3} z_t^{\text{gscp}} \times TO_{i,t-1} + \beta_{h,4} z_t^{\text{gscp}} \times GTVI_{i,t-1}^{TVP} + \Gamma'_h X_{i,t-1} + \mu_{i,h} + \varepsilon_{i,t,h}, \quad (1)$$

where $\pi_{i,t}$ denotes CPI inflation, z_t^{gscp} is the global trade-disruption innovation,[1] $TO_{i,t-1}$ measures trade openness, and $GTVI_{i,t-1}^{TVP}$ is a time-varying index of trade vulnerability derived from the global trade vulnerability factor.[2] The control vector $X_{i,t-1}$ includes lagged inflation, output growth, exchange-rate changes, commodity prices, and other domestic or global macroeconomic indicators. Country fixed effects $\mu_{i,h}$ capture persistent cross-country differences, while time fixed effects are

[1]The GSCP shock is obtained as the standardized residual from an autoregressive (AR) or AR-X model of the GSCPI. The AR-X specification controls for GSCPI persistence, seasonally adjusted world industrial production, and financial market volatility (VIX) to isolate unexpected supply-chain disturbances. Lag selection follows the Bayesian information criterion over one to four lags. Because z_t^{gscp} is a generated regressor, the reported LP standard errors do not account for first-stage estimation uncertainty, which may affect inference (Pagan, 1984). For this reason, the LP results are interpreted cautiously. As diagnostic checks, we compute approximate confidence bands for the AR and AR-X residual-based shocks based on uncertainty in the fitted first-stage conditional mean, and we also report robustness using the standardized first difference of the GSCPI as a model-light alternative shock construction.

[2]Appendix A provides a detailed explanation of the time-varying parameter factor-augmented vector autoregression (TVP-FAVAR) framework, data construction, factor extraction, and filtering procedure used to obtain the GTVI measure.

excluded to preserve identification of the common global shock.[3] This specification allows the direct inflationary effect of global trade disruptions to vary with structural exposure. The coefficient $\beta_{h,0}$ captures the average cost-push effect of the shock, $\beta_{h,3}$ reflects how openness modifies the transmission of the shock, and $\beta_{h,4}$ captures the amplification associated with trade vulnerability.

To allow for state-dependent transmission, the specification is extended to incorporate volatility regimes in global trade conditions. Let D_t^H denote an indicator that equals one during periods of elevated volatility in GSCP and zero otherwise. This regime indicator is intended to capture periods in which global supply-chain conditions are more unstable. Since such periods may involve both larger GSCP innovations and changes in the pass-through of those innovations, the regime-specific estimates are interpreted as reduced-form differences in inflation responses across volatility states rather than as a clean decomposition between shock size and transmission elasticity. The regime-dependent specification becomes

$$\begin{aligned}\pi_{i,t+h} - \pi_{i,t-1} = \alpha_h + \beta_{h,0} z_t^{\text{gscp}} + \beta_{h,1} TO_{i,t-1} + \beta_{h,2} GTVI_{i,t-1}^{TVP} \ldots \\ + \beta_{h,3} z_t^{\text{gscp}} \times TO_{i,t-1} + \beta_{h,4} z_t^{\text{gscp}} \times GTVI_{i,t-1}^{TVP} + \beta_{h,5} z_t^{\text{gscp}} \times D_t^H + \beta_{h,6} z_t^{\text{gscp}} \times TO_{i,t-1} \times D_t^H \ldots \\ + \beta_{h,7} z_t^{\text{gscp}} \times GTVI_{i,t-1}^{TVP} \times D_t^H + \Gamma_h' X_{i,t-1} + \mu_{i,h} + \varepsilon_{i,t,h}, \quad (2)\end{aligned}$$

which allows both the baseline shock effect and its interaction with openness and vulnerability to vary across volatility regimes. In this formulation, $\beta_{h,5}$ captures the additional inflationary impact of global trade disruptions during high-volatility periods, while $\beta_{h,6}$ and $\beta_{h,7}$ capture how openness and vulnerability modify this regime-dependent transmission.

The implied horizon-h impulse responses for a country with openness level to and vulnerability level g can be expressed as

$$\begin{aligned}\text{IRF}_\pi(h \mid to, g, \sigma_{\text{low}}) &= \beta_{h,0} + \beta_{h,3} to + \beta_{h,4} g, \\ \text{IRF}_\pi(h \mid to, g, \sigma_{\text{high}}) &= \beta_{h,0} + \beta_{h,3} to + \beta_{h,4} g + \beta_{h,5} + \beta_{h,6} to + \beta_{h,7} g.\end{aligned}$$

Comparing these responses across regimes allows an assessment of whether inflationary effects are systematically stronger during periods of heightened global trade disruption and whether such amplification is unique in economies with higher trade vulnerability.

Local projections are estimated separately for each horizon $h = 0, 1, \ldots, 8$ quarters. Inference is based on two alternative variance estimators reported throughout. The first uses heteroskedasticity-robust (HC) standard errors clustered at the country level, which account for within-country serial correlation over time. The second uses Driscoll-Kraay (DK) standard errors as a robustness check; the DK estimator allows for both serial correlation and cross-sectional dependence across countries,

[3] Global commodity prices, oil prices, and financial conditions are included as controls in the richer specifications to partial out other common global factors without absorbing the shock of interest.

and is particularly relevant here given that the common global shock may induce contemporaneous correlation in inflation dynamics across ASEAN-5 economies. Where the two sets of confidence intervals diverge materially, the DK-based intervals are treated as the more conservative benchmark.

Impulse responses are computed under three alternative control configurations. The baseline specification includes lagged inflation and lagged values of z_t^{gscp} to remove predictable serial dependence in the dependent variable prior to estimation. Alternative specification 1 augments this with domestic macroeconomic controls–the output gap, real exchange-rate changes, and additional lags of inflation–to account for domestic cyclical conditions that may covary with the shock. Alternative specification 2 further adds global commodity price inflation, oil price inflation, and changes in the monetary policy rate to capture external cost pressures and endogenous policy responses. These global controls are included in levels rather than as fixed effects so as not to absorb the common variation in z_t^{gscp} that provides identification, consistent with the time-fixed-effects exclusion discussed above.

2.3 Results and discussion

The LP results provide reduced-form evidence on the inflationary effects of global trade-disruption shocks across alternative specifications and volatility regimes, while the DSGE simulations offer a structural interpretation of these empirical findings and extend the analysis to examine how monetary policy stance shapes the propagation of such shocks.

2.3.1 Baseline impulse responses

Figures 2-4 present the response of inflation to a GSCP shock under the baseline and progressively richer specifications. The baseline specification includes the shock and its interactions with trade openness and the trade vulnerability index, without additional macroeconomic controls. Alternative specification 1 augments this setup with standard domestic controls–namely inflation persistence, the output gap, real exchange rate changes, and trade openness dynamics–while alternative specification 2 further incorporates global cost-push and policy variables, including world commodity prices, oil prices, and changes in the monetary policy rate.

Across the three specifications, the main shock response displays a delayed, hump-shaped profile. Inflation initially responds weakly, rises over subsequent quarters, and reaches its largest point estimate around three to five quarters after the shock before gradually declining. This timing is consistent with gradual pass-through from external supply-chain disruptions to domestic prices. However, because the LP framework is reduced form, the estimates do not by themselves identify whether the delayed response operates through production networks, import prices, intermediate input costs, exchange rates, or other channels.

The shape and timing of the point estimates are broadly similar as domestic and global controls are added. The inclusion of output gap dynamics, exchange-rate movements, global commodity prices, oil prices, and policy-rate changes does not substantially alter the delayed profile of the response. This suggests that the main pattern is not entirely driven by the observed domestic cyclical and global cost variables included in the richer specifications, although identification limitations inherent to the LP approach remain.

The interaction terms provide more suggestive rather than conclusive evidence on heterogeneity. Trade openness does not systematically amplify the inflation response: the openness interaction is small, changes sign across horizons, and is generally statistically indistinguishable from zero. Trade vulnerability plays a more visible role in the point estimates, with more structurally exposed economies tending to exhibit larger and more persistent inflation responses. Nevertheless, the vulnerability interaction is estimated with considerable uncertainty, particularly under Driscoll-Kraay standard errors, so the result should be interpreted as suggestive rather than definitive.

The figures report confidence intervals based on both heteroskedasticity-consistent (HC) and Driscoll-Kraay (DK) standard errors. The DK intervals are generally wider, as expected, but the delayed profile of the main response remains visible across the two inference approaches. Statistical significance at individual horizons and the interaction effects should therefore be interpreted cautiously.

2.3.2 Regime-specific impulse responses

Figures 5-7 present the impulse responses of inflation to a GSCP shock across high- and low-volatility regimes of the GSCPI. The regimes are defined using rolling volatility of the estimated trade-disruption innovation, allowing the transmission of shocks to vary with the stability of global supply-chain conditions. In contrast to the full-sample estimates, the regime-specific responses rely on heteroskedasticity-consistent (HC) standard errors because the smaller subsample dimension makes Driscoll-Kraay corrections less reliable.

The point estimates suggest an asymmetry across regimes. In high-volatility periods, the main inflation response is more consistently positive and displays a clearer hump-shaped profile, with effects concentrated at medium horizons. This pattern is consistent with stronger inflationary responses when global logistics conditions are already strained. However, the interpretation of the regime split requires caution. A high-volatility regime may reflect larger realized GSCP innovations, a change in the propagation of shocks, or both. The LP estimates show that inflation responses differ across volatility states, but the reduced-form specification does not fully disentangle whether this difference reflects larger shocks hitting the economy or a higher transmission elasticity during stressed supply-chain conditions. In low-volatility periods, the estimated responses are less stable: they are often close to zero, sometimes negative at longer horizons, and surrounded by wide confidence bands. The evidence therefore points to stronger inflation responses during high-volatility episodes, but the regime-specific estimates should be interpreted as suggestive rather than definitive evidence of nonlinear propagation.

The interaction terms provide only tentative evidence on heterogeneity within regimes. Trade openness does not appear to systematically amplify inflation responses in either regime. Trade vulnerability is more relevant in the point estimates, especially during high-volatility episodes, but the confidence bands are wide and overlap across specifications. The regime-specific results therefore support the broader interpretation that volatility conditions matter for GSCP pass-through, while providing suggestive rather than conclusive evidence on whether high-volatility episodes reflect stronger nonlinear propagation, larger effective shocks, or both.

2.3.3 Robustness checks

We conduct additional robustness checks to assess whether the LP results are sensitive to country composition, small-sample inference, crisis-period dynamics, the definition of high-volatility GSCP regimes, and the construction of the GSCP shock. Table 4 summarizes the main findings. The checks cover seven exercises. First, we re-estimate the specifications excluding Singapore, the most open and trade-hub-oriented economy in the ASEAN-5 sample. Second, we conduct a leave-one-country-out exercise by excluding one ASEAN-5 economy at a time. Third, we estimate wild-cluster bootstrap confidence bands for the preferred specification, clustering bootstrap weights at the country level. Fourth, we add a COVID-19 disruption-period dummy to preserve pandemic-era GSCP variation while allowing for a crisis-period level shift in inflation dynamics. Fifth, we exclude the COVID-19 disruption period as a stricter sensitivity check. Sixth, we redefine the high-volatility regime using a stricter top-quartile threshold of rolling GSCPI innovation volatility instead of the baseline median split. Seventh, we replace the baseline residual-based GSCP shock with the standardized first difference of the GSCPI as a model-light alternative shock construction. Except for the standardized ΔGSCPI exercise, these checks use the baseline GSCP shock, constructed as the standardized residual from an AR-X specification of the GSCPI that controls for GSCPI persistence, seasonally adjusted world industrial production, and the VIX, with lag length selected by BIC over one to four lags.

We first examine sensitivity to country composition. Singapore is a small open economy, but its role as a regional trade and re-export hub makes its openness ratio and external-sector structure unusual relative to the rest of the ASEAN-5 sample. Excluding Singapore therefore helps assess whether the baseline findings are driven by Singapore's trade-hub characteristics or remain visible among economies with less extreme openness ratios. The exclusion of Singapore does not overturn the main empirical interpretation. The estimated response to the GSCP shock remains positive and visible, while the openness interaction remains small and imprecisely estimated. The trade-vulnerability interaction also remains positive in the point estimates, although its magnitude is somewhat weaker than in the full-sample specification.

To further assess small-panel sensitivity, we re-estimate the preferred specification by excluding one ASEAN-5 economy at a time. This leave-one-country-out exercise shows that the main GSCP shock response remains positive and hump-shaped across all exclusions, with the peak response consistently occurring around horizon 3. The medium-horizon trade-vulnerability interaction also remains positive regardless of which country is excluded, although its magnitude and statistical significance vary across exclusions and standard-error corrections. By contrast, the openness interaction remains small and less stable across country exclusions. These results suggest that the main empirical interpretation is not driven by Singapore or by any single economy, while reinforcing the need to interpret the LP estimates cautiously given the small cross-country dimension of the ASEAN-5 panel.

As an additional small-sample inference check, we estimate wild-cluster bootstrap confidence bands for the preferred LP specification, clustering the bootstrap weights at the country level. The results support the baseline finding that GSCP shocks have a delayed inflationary effect: the main shock response is positive and statistically different from zero at horizons 2 to 4, with the peak response around horizon 3. The openness interaction does not show sustained medium-horizon amplification. It is positive at short horizons but becomes negative at longer horizons, suggesting that openness alone is not a stable amplification channel. The GTVI interaction is positive at selected medium horizons, including horizons 3 and 5, but the horizon-by-horizon path is less smooth and should be interpreted cautiously. Thus, the wild-cluster bootstrap results support the qualitative interpretation that trade vulnerability is more informative than openness for medium-horizon GSCP pass-through, while also confirming that inference remains sensitive in a panel with only five country clusters.

We next assess sensitivity to the COVID-19 period. The baseline sample contains the COVID-19 episode, which is an important source of global supply-chain stress but may also introduce unusual inflation dynamics. We therefore estimate a specification that includes a COVID-period dummy, preserving pandemic-era GSCP variation while allowing for a crisis-period level shift in inflation dynamics. The results are broadly consistent with the baseline in showing weak amplification through trade openness and a more visible role for trade vulnerability in the point estimates. However, the main shock response becomes less stable across horizons, indicating that the pandemic period contributes materially to the estimated dynamics. As a stricter sensitivity check, we also exclude the COVID period. This exercise removes an important episode of global supply-chain disruption and therefore should not be viewed as the preferred specification. The estimated responses become less stable and less precisely estimated, consistent with the reduced identifying variation after removing the largest supply-chain stress episode in the sample.

As a threshold-sensitivity check, we redefine the high-volatility regime using the top quartile of rolling GSCPI innovation volatility instead of the median split. Under this stricter definition, the regime-specific IRFs become noisier and the separation between high- and low-volatility periods is less clear, reflecting the smaller number of observations classified as high-volatility episodes. The openness interaction continues to show no sustained amplification, while the GTVI interaction remains positive at selected horizons but is less precisely estimated. These results suggest that the regime-dependent evidence should be interpreted as suggestive rather than definitive: inflation responses appear more pronounced in unstable supply-chain environments under the baseline median split, but sharp threshold-based regime differences are sensitive to the volatility cutoff.

Finally, we examine whether the results are sensitive to the first-stage construction of the GSCP shock. The baseline AR-X shock is preferred because it nets out GSCPI persistence, global activity, and financial-stress conditions, while allowing the lag structure to be selected by BIC rather than imposed arbitrarily. However, since the shock is generated from a first-stage regression, the associated LP confidence intervals do not fully incorporate first-stage estimation uncertainty. As a diagnostic exercise, we compute approximate confidence bands for the AR and AR-X residual-based shocks based on uncertainty in the fitted first-stage conditional mean. These bands illustrate first-stage shock-estimation uncertainty, but they do not constitute a full generated-regressor correction for the LP confidence intervals. As a model-light robustness check, we therefore re-estimate the LP specifications using the standardized first difference of the GSCPI. This alternative shock does not rely on estimating an AR or AR-X first-stage equation. The resulting impulse responses are less stable than the baseline AR-X estimates, which is expected because the first-difference measure is noisier and does not net out global activity or financial-stress conditions. Nevertheless, the qualitative pattern remains informative: the openness interaction continues to show no systematic amplification, while the GTVI interaction remains more visible in the point estimates, especially at medium horizons and in richer specifications.

These robustness checks support a cautious interpretation of the LP evidence. The delayed inflation response and the stronger role of trade vulnerability are not entirely driven by Singapore, by any single ASEAN-5 economy, by one treatment of the COVID period, or by the baseline residual-based shock construction. The qualitative conclusions also remain broadly similar across heteroskedasticity-consistent, Driscoll-Kraay, and wild-cluster bootstrap confidence intervals, as well as across parsimonious and richer LP specifications. At the same time, the estimates remain sensitive to crisis-period treatment, shock measurement, and small-panel inference. Since the ASEAN-5 panel has a limited cross-sectional dimension, the standard-error corrections should not be interpreted as fully resolving finite-sample inference concerns. The robustness evidence should therefore be read as supporting the qualitative interpretation of vulnerability-dependent pass-through, rather than as providing definitive horizon-by-horizon inference.

3 DSGE Model and Results

The empirical results leave a clear interpretive gap for the model to fill. The LP evidence shows when inflation responds more strongly to GSCP shocks: after a delay, in economies with greater trade vulnerability, and during more volatile global supply-chain conditions. What it cannot show directly is how these responses travel through imported-input costs, firms' marginal costs, external adjustment, and monetary-policy reactions.

Against this backdrop, the second part of the paper develops a nonlinear two-country New Keynesian DSGE model to examine the mechanisms through which global supply-chain disruptions transmit to domestic inflation, and how these mechanisms are shaped by trade vulnerability, GSCP shock volatility, and monetary-policy stance. The model is designed to interpret the empirical LP patterns in a small open economy rather than to serve as a fully estimated quantitative model for the ASEAN-5 panel. Its contribution lies not in the novelty of each individual block, but in integrating four elements in a single small-open-economy framework: imported-input cost pass-through, a trade-vulnerability channel, regime-switching GSCP shock volatility, and alternative monetary-policy stances. The simulations mirror the trade-vulnerability and GSCP-volatility dimensions emphasized in the empirical LP analysis, and extend them by examining how counterfactual policy regimes affect the persistence of imported-cost pass-through. This mapping provides a unified mechanism for interpreting how external cost shocks affect inflation, real activity, and external adjustment under different structural exposure, global volatility, and policy conditions.

The model is calibrated to the Indonesian economy because Indonesia provides a relevant small-open-economy setting for studying imported-input cost pass-through under external supply disruptions. Indonesia combines exposure to global supply-chain pressures, imported-input dependence, exchange-rate adjustment, and an active monetary-policy framework, making it a suitable benchmark for illustrating the mechanisms emphasized in the empirical analysis. The DSGE simulations are therefore used to interpret the transmission channels suggested by the LP evidence, rather than to replicate the average ASEAN-5 response quantitatively. The robustness check excluding Singapore supports this mapping by showing that the qualitative LP patterns are not driven solely by the region's most extreme trade-hub economy, suggesting that the mechanisms highlighted by the Indonesia calibration remain relevant for less extreme small-open-economy settings in the panel.

The mapping between the empirical GTVI and the DSGE vulnerability parameter is intentionally stylized. In the LP analysis, GTVI is a predetermined time-varying measure of exposure to global supply-chain disruptions, allowing vulnerability to vary across countries and over time. In the DSGE model, this empirical variation is summarized by a vulnerability parameter that governs the pass-through of GSCP shocks into delivered import prices and marginal costs. The model therefore does not attempt to reproduce the full stochastic evolution of GTVI. Instead, it uses alternative vulnerability values to examine how different degrees of structural exposure condition the transmission of a common GSCP shock. This abstraction keeps the model tractable while preserving the main mechanism suggested by the LP evidence: GSCP shocks generate stronger inflationary effects when trade vulnerability is higher.

The model also distinguishes between trade openness and trade vulnerability. Trade openness is captured by the import-intensity or external-exposure parameter $\omega_{nx,H}$, which affects the quantity side of the model through imports, net exports, and the resource constraint. By contrast, trade vulnerability is captured by $\phi_{nx,H}$, which affects the price side by amplifying the pass-through of GSCP shocks into delivered import prices and marginal costs. This distinction mirrors the empirical results, where openness does not systematically amplify inflation responses, while the point estimates suggest a stronger role for vulnerability. The DSGE simulations therefore focus on variation in $\phi_{nx,H}$ because the purpose of the structural exercise is to illustrate the imported-cost pass-through channel rather than to provide a full sensitivity analysis over all trade-related parameters.

Both $\omega_{nx,H}$ and $\phi_{nx,H}$ are treated as fixed structural parameters in the DSGE model. Allowing either parameter to evolve stochastically over time would require introducing additional state variables and re-solving the model. This extension would change the interpretation of the structural exercise and is left for future work.

3.1 Model setup

The DSGE model consists of a Home (H) and a Foreign (F) economy. In each country, infinitely lived representative households consume, supply labor, accumulate capital, and choose investment subject to adjustment costs following Christiano et al. (2005). A perfectly competitive final-good producer aggregates differentiated intermediate varieties, while monopolistically competitive intermediate-goods firms produce using capital and labor and set prices subject to Rotemberg adjustment costs. Technology follows a nonstationary stochastic trend. The monetary authority sets the nominal interest rate according to a Taylor-type rule, with the Home economy allowed to switch between hawkish and dovish policy regimes.

Two features of the model are important for linking the structural simulations to the empirical results. First, the model is nonlinear in the sense that the equilibrium conditions are solved using a perturbation-based DSGE solution under regime-switching GSCP shock volatility and monetary-policy regimes. It is therefore a nonlinear perturbation-based DSGE model, rather than a fully nonlinear dynamic-programming exercise. Second, the key external disturbance of interest is the GSCP shock, which is disciplined using the empirical GSCPI-based shock series. The estimated shock process informs the persistence and volatility of the external imported-cost disturbance. Trade vulnerability enters separately as an exposure parameter that governs the pass-through of global supply-chain pressure into delivered import prices and marginal costs.

It is useful to interpret the trade-vulnerability and policy-regime simulations primarily as amplification exercises, rather than as mechanisms that necessarily alter the full shape of the impulse responses. In the current specification, the vulnerability parameter enters the delivered import-price wedge multiplicatively. A higher value of $\phi_{nx,i}$ therefore increases the sensitivity of import prices, marginal costs, and inflation to a given GSCP shock, but it does not by itself introduce an additional dynamic propagation channel. The timing of the responses is still governed by the persistence of the GSCP process, nominal rigidities, investment adjustment costs, and the monetary-policy rule. As a result, higher vulnerability can generate a monotonic increase in the size of the response while leaving the broad shape of the IRFs largely unchanged. Similarly, hawkish and dovish policy regimes change the strength of inflation stabilization and the persistence of the adjustment, but they do not alter the underlying imported-cost transmission channel. The model therefore highlights state-dependent amplification rather than a fundamentally different propagation mechanism across vulnerability and policy regimes.

The two economies are linked through a trade block and an exchange-rate block. In the trade block, Home net exports depend on relative output and domestic absorption, capturing the idea that leakage is stronger in more open economies. The exchange-rate block follows a reduced-form UIP-type specification with a persistent risk premium. The key external disturbance is global supply-chain pressure, modeled as an iceberg or shipping-cost wedge on imported intermediate inputs. This wedge raises the effective delivered price of imported inputs and operates as an imported-cost shock. Its pass-through to marginal costs is amplified by a trade-vulnerability parameter, allowing structurally exposed economies to experience stronger inflationary effects from the same GSCP shock.

The model distinguishes this GSCP shock from domestic markup disturbances and risk-premium shocks. The GSCP shock enters through the delivered import-price wedge and is transmitted to firms' marginal costs through the imported-input channel. By contrast, the domestic markup disturbance operates through $\eta_{i,t}$ in the Phillips curve. Under the model's sign convention, a positive innovation to $\eta_{H,t}$ lowers the desired markup; hence, a conventional inflationary markup or cost-push disturbance corresponds to the opposite sign of this shock. The risk-premium shock affects the exchange-rate and external-adjustment block through the reduced-form UIP equation, but it does not directly enter the delivered import-price equation in the current specification. The DSGE simulations therefore focus on GSCP shocks because they correspond most closely to the empirical LP shock and to the imported-cost pass-through mechanism emphasized in the paper.

3.1.1 Households

Households in country $i \in \{H, F\}$ maximize expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln(c_{i,t}) - \chi_0 \frac{h_{i,t}^{1+\chi}}{1+\chi} \right], \tag{3}$$

where $c_{i,t}$ is consumption, $h_{i,t}$ is labor, $\beta \in (0,1)$ is the subjective discount factor, $\chi_0 > 0$ scales the disutility of labor, and χ is the inverse Frisch elasticity of labor supply. Optimality with respect to labor supply yields

$$\frac{w_{i,t}}{c_{i,t}} = \chi_0 h_{i,t}^{\chi}, \tag{4}$$

where $w_{i,t}$ is the real wage.

The optimality condition for nominal one-period bonds, taking into account nonstationary technology growth, is

$$1 = \beta\, E_t \left[\frac{R_{i,t}}{\pi_{i,t+1}} \frac{c_{i,t}}{\pi^Z_{i,t+1} c_{i,t+1}} \right], \tag{5}$$

where $R_{i,t}$ is the gross nominal interest rate, $\pi_{i,t}$ is gross CPI inflation, and $\pi^Z_{i,t}$ is the gross growth rate of technology.

Capital Accumulation and Investment Adjustment Costs Households own the capital stock and choose investment subject to adjustment costs. Capital evolves according to

$$k_{i,t} = (1-\delta)\frac{k_{i,t-1}}{\pi^Z_{i,t}} + i_{i,t}\left[1 - \frac{\varphi}{2}\left(\frac{i_{i,t}}{i_{i,t-1}} - 1\right)^2\right], \tag{6}$$

where δ is the depreciation rate, φ governs the strength of investment adjustment costs, and $\pi^Z_{i,t}$ denotes gross technology growth. Let $q_{i,t}$ denote the shadow value of installed capital, or Tobin's Q.

The Euler equation for capital is

$$q_{i,t} = \beta E_t \left[\frac{c_{i,t}}{c_{i,t+1}} \frac{1}{\pi^Z_{i,t+1}} \left(R^k_{i,t+1} + (1-\delta) q_{i,t+1} \right) \right], \tag{7}$$

where the real rental return on capital is given by

$$R^k_{i,t} = \mathsf{MPK}_{i,t} \frac{w_{i,t}}{\mathsf{MPL}_{i,t}}. \tag{8}$$

The first-order condition for investment is

$$1 = q_{i,t}\left[1 - \frac{\varphi}{2}\left(\frac{i_{i,t}}{i_{i,t-1}} - 1\right)^2 - \varphi\left(\frac{i_{i,t}}{i_{i,t-1}} - 1\right)\frac{i_{i,t}}{i_{i,t-1}}\right] + \beta E_t \left[\frac{c_{i,t}}{c_{i,t+1}} q_{i,t+1} \varphi \left(\frac{i_{i,t+1}}{i_{i,t}} - 1\right)\left(\frac{i_{i,t+1}}{i_{i,t}}\right)^2 \right]. \tag{9}$$

Equation (9) equates the marginal cost of one unit of investment to its marginal value in terms of installed capital. The first term on the right-hand side captures the contemporaneous contribution of investment to capital accumulation. When investment growth differs from its steady-state value, part of current investment is absorbed by adjustment costs, reducing the amount of effective capital created by an additional unit of investment. The second term captures the forward-looking effect of current investment on future adjustment costs. Because the adjustment cost depends on the ratio $i_{i,t+1}/i_{i,t}$, a higher current level of investment changes the cost of adjusting investment in the next period. As a result, investment is smoothed over time: households internalize not only the current effect of investment on installed capital, but also its effect on the future cost of changing investment.

3.1.2 Firms

The production side follows the standard New Keynesian distinction between a competitive final-good producer and monopolistically competitive intermediate-goods firms. The final-good producer aggregates differentiated intermediate varieties, which generates downward-sloping demand for each variety. Intermediate-goods firms produce differentiated goods, face this demand curve, and set prices subject to nominal rigidities. This structure follows the canonical New Keynesian setup in which the final-good sector is competitive and the pricing decision is made by intermediate producers.

Technology and Markup Processes Each country features a cost-push, or markup, process and a nonstationary technology process. The country-specific elasticity of substitution across differentiated intermediate goods, $\eta_{i,t}$, evolves as

$$\log \eta_{i,t} = (1-\rho_\eta)\log \eta + \rho_\eta \log \eta_{i,t-1} + \sigma_\eta \varepsilon^{\eta}_{i,t}, \tag{10}$$

where $\eta > 1$ is the steady-state elasticity, ρ_η is the persistence parameter, σ_η is the standard deviation of the cost-push innovation, and $\varepsilon^{\eta}_{i,t}$ is an i.i.d. shock.

Technology is nonstationary and follows

$$\log \pi^{Z}_{i,t} = (1-\rho_z)\log \mu + \rho_z \log \pi^{Z}_{i,t-1} + \sigma_z \varepsilon^{z}_{i,t}, \tag{11}$$

where μ is the steady-state gross technology growth factor and $\pi^{Z}_{i,t}$ denotes the gross growth rate of the permanent technology component. This formulation allows the model to incorporate stochastic trend growth while keeping the equilibrium conditions expressed in stationary transformed variables. The parameter ρ_z controls the persistence of technology-growth deviations from steady state, and σ_z governs the volatility of technology-growth shocks.

Final-Good Producer In each country $i \in \{H, F\}$, a perfectly competitive final-good producer aggregates differentiated intermediate varieties $j \in [0, 1]$ according to the CES technology

$$y_{i,t} = \left[\int_0^1 y_{i,t}(j)^{\frac{\eta_{i,t}-1}{\eta_{i,t}}} dj\right]^{\frac{\eta_{i,t}}{\eta_{i,t}-1}}, \tag{12}$$

where $\eta_{i,t} > 1$ is the time-varying elasticity of substitution across varieties. Cost minimization by the final-good producer implies the demand function for each intermediate variety,

$$y_{i,t}(j) = \left(\frac{P_{i,t}(j)}{P_{i,t}}\right)^{-\eta_{i,t}} y_{i,t}, \tag{13}$$

and the aggregate price index

$$P_{i,t} = \left[\int_0^1 P_{i,t}(j)^{1-\eta_{i,t}} dj\right]^{\frac{1}{1-\eta_{i,t}}}. \tag{14}$$

Imported-Input Cost Channel and Marginal Cost This subsection motivates the reduced-form imported-input cost channel used in the numerical implementation. The solved model use the Cobb-Douglas production function in equation (15), and global supply-chain disruptions enter through the delivered import price $p^m_{i,t}$ and the marginal-cost equation below. The auxiliary static cost-minimization problem is not part of the solved production block; it is used to show why an increase in delivered import prices can be interpreted as raising marginal costs when firms rely on imported intermediate inputs.

Technology with a variable-input requirement. Fix a country $i \in \{H, F\}$. For a given output level $y_{i,t}$ and predetermined capital stock $k_{i,t-1}$, suppose an intermediate firm chooses labor $h_{i,t}$ and imported intermediate inputs $m_{i,t}$ to satisfy

$$y_{i,t} = k^{\nu}_{i,t-1}\Big[\mathcal{V}(h_{i,t}, m_{i,t})\Big]^{1-\nu}, \tag{15}$$

where $\mathcal{V}(\cdot,\cdot)$ is a variable-input aggregator combining labor and imported intermediates. We adopt a Cobb-Douglas form

$$\mathcal{V}(h_{i,t}, m_{i,t}) = h_{i,t}^{1-\xi_{m,i}} m_{i,t}^{\xi_{m,i}}, \qquad \xi_{m,i} \in (0, 1), \tag{16}$$

so that the static problem implies a constant expenditure share $\xi_{m,i}$ on imported intermediates. In the model implementation, $\xi_{m,i}$ corresponds to the imported-input cost intensity parameter.

Define the required composite variable input as

$$v_{i,t} \equiv \mathcal{V}(h_{i,t}, m_{i,t}) = \left(\frac{y_{i,t}}{k_{i,t-1}^{\nu}} \right)^{\frac{1}{1-\nu}}. \tag{17}$$

The variable-input constraint can then be written as

$$v_{i,t} = h_{i,t}^{1-\xi_{m,i}} m_{i,t}^{\xi_{m,i}}.$$

Static cost-minimization problem. Let $w_{i,t}$ denote the real wage and $p_{i,t}^m$ the real delivered price of imported intermediates. Conditional on $(k_{i,t-1}, y_{i,t})$, the firm solves

$$\min_{h_{i,t}, m_{i,t}} \; w_{i,t} h_{i,t} + p_{i,t}^m m_{i,t} \quad \text{s.t.} \quad h_{i,t}^{1-\xi_{m,i}} m_{i,t}^{\xi_{m,i}} = v_{i,t}. \tag{18}$$

The first-order conditions imply the conditional factor demand

$$\frac{m_{i,t}}{h_{i,t}} = \frac{\xi_{m,i}}{1-\xi_{m,i}} \frac{w_{i,t}}{p_{i,t}^m}, \tag{19}$$

so that an increase in the delivered import price $p_{i,t}^m$, for example due to GSCP, induces substitution away from imported intermediates toward labor in the auxiliary static problem.

Unit cost of the composite input. For the Cobb-Douglas variable-input aggregator, the minimized cost of producing one unit of $v_{i,t}$ is

$$UC_{i,t}^V = \frac{w_{i,t}^{1-\xi_{m,i}} \left(p_{i,t}^m\right)^{\xi_{m,i}}}{(1-\xi_{m,i})^{1-\xi_{m,i}} (\xi_{m,i})^{\xi_{m,i}}}, \tag{20}$$

so that total variable cost is

$$VC_{i,t} = UC_{i,t}^V \, v_{i,t} = UC_{i,t}^V \left(\frac{y_{i,t}}{k_{i,t-1}^{\nu}} \right)^{\frac{1}{1-\nu}}. \tag{21}$$

Holding $k_{i,t-1}$ fixed, the real marginal cost in the auxiliary problem is

$$mc_{i,t}^{aux} \equiv \frac{\partial VC_{i,t}}{\partial y_{i,t}} = \frac{UC_{i,t}^V}{1-\nu} \left(\frac{y_{i,t}}{k_{i,t-1}^{\nu}} \right)^{\frac{\nu}{1-\nu}} k_{i,t-1}^{-\nu}. \tag{22}$$

Equation (22) shows that the delivered import price enters marginal cost with elasticity $\xi_{m,i}$.

Mapping to the implemented exposure closure. Under the fully microfounded auxiliary problem, the import share varies endogenously with $p_{i,t}^m$ through the optimality condition above. For tractability, the numerical implementation adopts the reduced-form approximation

$$m_{i,t} = \omega_{nx,i} y_{i,t}, \tag{23}$$

which can be interpreted as an approximation around a steady state in which imported-intermediate requirements per unit output are approximately constant. Under equation (23), trade openness $\omega_{nx,i}$ primarily governs exposure through quantities and the trade/leakage block, while the delivered import price $p^m_{i,t}$ captures the exogenous cost push from GSCP.

Implication for GSCP pass-through. The auxiliary cost-minimization problem above motivates the imported-input channel, but the numerical implementation adopts a simpler reduced-form marginal-cost specification:[4]

$$\log mc_{i,t} = \log w_{i,t} - \log\left((1-\nu)\frac{y_{i,t}}{h_{i,t}}\right) + \xi_{m,i} \log p^m_{i,t}. \tag{24}$$

This specification preserves the key imported-input cost channel while keeping the capital block tractable. The parameter $\xi_{m,i}$ governs the elasticity of marginal cost with respect to delivered import prices.

Given the shipping-cost mapping

$$\log p^m_{i,t} = \gamma_{\text{ship}} (1 + \phi_{nx,i})^{\vartheta_\phi} z^{\text{gscp}}_t, \tag{25}$$

the GSCP elasticity of marginal cost in the implemented model is

$$\frac{\partial \log mc_{i,t}}{\partial z^{\text{gscp}}_t} = \xi_{m,i} \gamma_{\text{ship}} (1 + \phi_{nx,i})^{\vartheta_\phi}. \tag{26}$$

Equation (26) summarizes the model's imported-cost pass-through mechanism. The parameter γ_{ship} governs the direct sensitivity of delivered import prices to global supply-chain pressure, while $\xi_{m,i}$ determines how strongly delivered import prices enter firms' marginal costs. The vulnerability parameter $\phi_{nx,i}$ scales the exposure of the economy to global logistics stress, and ϑ_ϕ allows this amplification to be nonlinear. When $\vartheta_\phi > 1$, a given GSCP shock has a disproportionately larger effect on marginal costs in economies with higher structural vulnerability. External vulnerability $\phi_{nx,i}$ therefore amplifies the pass-through of global logistics stress into marginal costs, and hence into inflation through the Rotemberg Phillips curve.

[4] The reduced-form specification is used as an implementation strategy to preserve tractability given the model's nonlinear regime-switching structure. It keeps the key imported-input cost channel while avoiding additional factor-demand conditions from fully endogenous substitution among labor, capital, and imported intermediates. Capital still affects marginal cost indirectly through labor productivity, while the imported-input margin enters as an additive delivered-price wedge. A fully microfounded treatment with endogenous factor substitution is left for future work.

This channel differs from the role of trade openness in the model. The openness parameter $\omega_{nx,i}$ scales import intensity and quantity-side external exposure, and therefore mainly affects quantities, absorption, and net exports. It does not directly enter the delivered import-price wedge. By contrast, $\phi_{nx,i}$ enters the import-price mapping directly and therefore has a more immediate effect on marginal costs and inflation. This is why the vulnerability experiment is more informative for the imported-cost pass-through mechanism emphasized in the DSGE analysis.

It is useful to distinguish the GSCP shock from a standard cost-push shock. In the model, the standard cost-push shock is a domestic markup shock that operates through the time-varying elasticity of substitution $\eta_{i,t}$ and affects inflation through the Phillips curve. By contrast, the GSCP shock is an external shipping or import-cost wedge. It first raises the delivered price of imported intermediate inputs, $p^m_{i,t}$, and then feeds into firms' marginal costs through the imported-input cost channel. The inflationary effect of the GSCP shock is therefore mediated by import-cost pass-through and amplified by the trade-vulnerability parameter $\phi_{nx,i}$.

The risk-premium shock plays a different role. It affects the exchange-rate variable through the reduced-form UIP block, but it does not directly enter the delivered import-price equation in the current specification. The import-price wedge is specified as a function of the GSCP shock and trade vulnerability. Therefore, the DSGE simulations focus on GSCP shocks because they correspond most closely to the empirical LP shock and to the paper's main mechanism of imported-cost pass-through. A richer specification with explicit exchange-rate pass-through into delivered import prices is a useful extension but would require recalibration and is left for future work.

Price Setting and New Keynesian Phillips Curve Intermediate-goods firms set prices subject to Rotemberg adjustment costs. Let $\pi_{i,t}$ denote gross inflation and π^* be the steady-state inflation target. Price adjustment costs are incurred when inflation deviates from an indexed benchmark that combines lagged inflation and the steady-state target:

$$\mathcal{C}^{\text{price}}_{i,t} = \frac{\kappa}{2}\left(\pi_{i,t} - \pi^{\alpha}_{i,t-1}(\pi^*)^{1-\alpha}\right)^2 y_{i,t}, \tag{27}$$

where κ is the adjustment cost parameter and α controls the degree of indexation to past inflation. A larger κ implies stickier prices, while a larger α increases the backward-looking component of inflation dynamics.

The Rotemberg Phillips curve can be written as

$$\begin{aligned} 0 = (1-\eta_{i,t}) + \eta_{i,t}\, mc_{i,t} - \kappa\left(\pi_{i,t} - \pi^{\alpha}_{i,t-1}(\pi^*)^{1-\alpha}\right)\pi_{i,t} \\ + \beta\kappa\, E_t\left[\left(\pi_{i,t+1} - \pi^{\alpha}_{i,t}(\pi^*)^{1-\alpha}\right)\pi_{i,t+1}\frac{c_{i,t}}{c_{i,t+1}}\frac{y_{i,t+1}}{y_{i,t}}\right], \end{aligned} \tag{28}$$

where $mc_{i,t}$ is real marginal cost. The first two terms capture the desired markup relation between prices and marginal costs, while the remaining terms reflect current and expected future price-adjustment costs. Through Equation (24), GSCP shocks raise $mc_{i,t}$ by increasing the delivered price of imported inputs. The Phillips curve therefore provides the final link from global supply-chain disruptions to domestic inflation: the stronger the imported-cost pass-through into marginal cost, the larger the inflationary pressure generated by a given GSCP shock.

3.1.3 Monetary policy

The Home monetary authority sets the nominal interest rate according to a Taylor-type rule with interest-rate smoothing. The strength of the inflation response varies across hawkish and dovish monetary policy regimes:

$$\frac{R_{H,t}}{R_H^{\text{ss}}} = \left(\frac{R_{H,t-1}}{R_H^{\text{ss}}}\right)^{\rho} \left(\frac{\pi_{H,t}}{\pi^*}\right)^{\psi(s_t^{mp})(1-\rho)} \exp(\sigma_r \varepsilon_{H,t}^R), \tag{29}$$

where R_H^{ss} is the steady-state gross nominal interest rate, ρ governs interest-rate smoothing, and $\varepsilon_{H,t}^R$ is an i.i.d. monetary-policy shock. The regime-dependent inflation-response coefficient is

$$\psi(s_t^{mp}) = \begin{cases} \psi^{\text{hawk}} & \text{if } s_t^{mp} = \text{hawkish}, \\ \psi^{\text{dov}} & \text{if } s_t^{mp} = \text{dovish}, \end{cases} \qquad \psi^{\text{hawk}} > \psi^{\text{dov}}. \tag{30}$$

The hawkish regime represents a stronger systematic response to inflation deviations from target, while the dovish regime represents a more accommodative response. This specification introduces state dependence in Home monetary policy and allows the model to examine how the strength of the policy response conditions the propagation of GSCP shocks. The regime-specific coefficients ψ^{hawk} and ψ^{dov}, together with the transition probabilities governing s_t^{mp}, are calibrated in the quantitative exercises. In the baseline calibration, the hawkish regime assigns a stronger inflation response than the dovish regime, while both regimes retain the same interest-rate smoothing parameter.

In the regime-switching model, the Markov transition probabilities are fixed exogenous parameters, but they remain important because they determine agents' expectations about future regimes. A regime-specific impulse response is therefore conditional not only on the GSCP-volatility or monetary-policy regime prevailing at the time of the shock, but also on the probability that the economy may switch to another regime in subsequent periods. For example, if the high-volatility GSCP regime is expected to be persistent, firms and households internalize a longer expected period of elevated supply-chain uncertainty and potentially larger future imported-cost disturbances. This affects forward-looking decisions and equilibrium objects such as inflation, consumption, investment, marginal cost, and the policy rate. Conversely, if the probability of returning to the low-volatility regime is high, the same realized GSCP shock is evaluated in an environment where elevated volatility is expected to be shorter-lived.

A useful limiting benchmark is the fixed-regime case in which the off-diagonal switching probabilities are set to zero and the diagonal probabilities are set to one. In that case, the current regime becomes absorbing, and the impulse response removes expected future regime switching. Comparing this fixed-regime benchmark with the baseline Markov-switching response would indicate how much of the model dynamics reflects expected regime transitions rather than the current realized regime. In the present analysis, the Markov-switching structure is used primarily to capture state-dependent propagation of GSCP shocks and monetary-policy responses. A formal decomposition of the response into current-regime effects and pure regime-switching expectation effects is left for future work.

The Foreign monetary authority follows a Taylor-type rule with fixed coefficients:

$$\frac{R_{F,t}}{R_F^{\text{ss}}} = \left(\frac{R_{F,t-1}}{R_F^{\text{ss}}}\right)^{\rho_F} \left(\frac{\pi_{F,t}}{\pi^*}\right)^{\psi_F(1-\rho_F)} \exp(\sigma_r \varepsilon_{F,t}^R), \tag{31}$$

where ρ_F and ψ_F are fixed policy-rule coefficients. The monetary-policy regime s_t^{mp} is distinct from the GSCP volatility regime s_t^{gscp}, so that policy stance and external shock volatility may vary independently.

3.1.4 Exchange rate dynamics and risk premium

Let s_t denote the log nominal exchange rate, defined so that an increase in s_t corresponds to a depreciation of the Home currency. Exchange-rate dynamics are summarized by a reduced-form UIP-type relation with persistence and a time-varying risk premium:[5]

$$rp_t = \rho_q rp_{t-1} + \sigma_q \varepsilon_t^q, \tag{32}$$

$$s_t = \rho_s s_{t-1} + \phi_s (R_{H,t} - R_{F,t}) + rp_t, \tag{33}$$

where ρ_q governs risk-premium persistence, σ_q is the standard deviation of the risk-premium innovation, ρ_s captures exchange-rate persistence, and ϕ_s governs the response of the exchange rate to the Home-Foreign interest-rate differential.

In the current specification, the risk-premium shock affects exchange-rate dynamics but does not directly enter the delivered import-price wedge. This modeling choice separates the GSCP-

[5] The reduced-form specification is adopted for tractability. It preserves the key external-adjustment channel through interest-rate differentials, exchange-rate persistence, and risk-premium shocks, while avoiding the need to model international bond markets, portfolio choice, and exchange-rate expectations explicitly.

driven imported-cost channel from the exchange-rate adjustment channel. Hence, risk-premium shocks affect the exchange-rate block, while GSCP shocks affect delivered import prices and marginal costs directly through the imported-input cost channel.

3.1.5 Global supply chain pressure and trade linkages

Global supply-chain pressure is modeled as an exogenous persistent disturbance with regime-switching volatility:

$$z_t^{\text{gscp}} = \rho_{z^{\text{gscp}}} z_{t-1}^{\text{gscp}} + \sigma_{z^{\text{gscp}}}(s_t^{\text{gscp}})\, \varepsilon_t^{\text{gscp}}, \tag{34}$$

where $\varepsilon_t^{\text{gscp}}$ is i.i.d. $\mathcal{N}(0,1)$ and the innovation variance depends on the latent volatility regime $s_t^{\text{gscp}} \in \{L, H\}$:

$$\sigma_{z^{\text{gscp}}}(s_t^{\text{gscp}}) = \begin{cases} \sigma^L_{z^{\text{gscp}}} & \text{if } s_t^{\text{gscp}} = L \text{ (low-volatility regime),} \\ \sigma^H_{z^{\text{gscp}}} & \text{if } s_t^{\text{gscp}} = H \text{ (high-volatility regime),} \end{cases} \tag{35}$$

with $\sigma^L_{z^{\text{gscp}}} < \sigma^H_{z^{\text{gscp}}}$. The regime s_t^{gscp} evolves as a two-state Markov chain with transition probabilities

$$\Pr(s_t^{\text{gscp}} = H \mid s_{t-1}^{\text{gscp}} = L) = p_{LH}, \qquad \Pr(s_t^{\text{gscp}} = L \mid s_{t-1}^{\text{gscp}} = H) = p_{HL}. \tag{36}$$

Regimes are persistent when p_{LH} and p_{HL} are small, and the unconditional probability of the high-volatility regime is

$$\pi_H = \frac{p_{LH}}{p_{LH} + p_{HL}}.$$

The low-volatility shock standard deviation $\sigma^L_{z^{\text{gscp}}}$ is calibrated to the standard deviation of GSCPI innovations during tranquil periods, while $\sigma^H_{z^{\text{gscp}}}$ is calibrated to episodes of elevated global supply-chain stress. This calibration is aligned with the rolling-volatility regime classification used in the local-projection analysis. The GSCP volatility regime s_t^{gscp} is distinct from the monetary-policy regime s_t^{mp}, allowing external uncertainty and policy stance to evolve independently.

GSCP affects the economy through the delivered import-price wedge introduced in Section 3.1.2. The trade block then captures how the real-side consequences of the shock are transmitted through external demand, domestic absorption, and import leakage. International linkages are summarized by a reduced-form net-exports equation for the Home economy:

$$NX_{H,t} = (y_{F,t} - y_{H,t}) + \lambda_{\text{leak}}\, \omega_{nx,H}\, (y_{H,t} - c_{H,t} - i_{H,t}), \tag{37}$$

with $NX_{F,t} = -NX_{H,t}$. The first term captures the relative-activity component: Home net exports improve when Foreign output rises relative to Home output. The second term captures the absorption/leakage channel. When domestic absorption rises relative to output, part of the additional demand leaks into imports; the strength of this channel is governed by λ_{leak} and scaled by the Home import-intensity parameter $\omega_{nx,H}$. Thus, trade openness affects external adjustment mainly through the quantity and absorption channel, while trade vulnerability affects inflation pass-through through the marginal-cost channel.

3.1.6 Resource constraints

The aggregate resource constraint in each economy equates domestic absorption to output net of price-adjustment costs and external adjustment. For the Home economy,

$$c_{H,t} + i_{H,t} = y_{H,t} - \frac{\kappa}{2}\left(\pi_{H,t} - \pi_{H,t-1}^{\alpha}(\pi^*)^{1-\alpha}\right)^2 y_{H,t} + \omega_{nx,H} NX_{H,t}, \tag{38}$$

and for the Foreign economy,

$$c_{F,t} + i_{F,t} = y_{F,t} - \frac{\kappa}{2}\left(\pi_{F,t} - \pi_{F,t-1}^{\alpha}(\pi^*)^{1-\alpha}\right)^2 y_{F,t} + \omega_{nx,F} NX_{F,t}. \tag{39}$$

The Rotemberg term represents real resources absorbed by price adjustment, so it reduces the amount of output available for consumption and investment. The net-export term captures the external contribution to domestic absorption, scaled by the import-intensity or openness parameter $\omega_{nx,i}$. A positive $NX_{i,t}$ increases resources available to the domestic economy, while a negative value reflects leakage through external absorption. Together with equation (37), this specification allows trade openness to affect the quantity side of external adjustment, while trade vulnerability affects inflation transmission through the imported-input marginal-cost channel.

3.2 Results and discussion

Table 5 summarizes the quarterly calibration used in the DSGE simulations. The Home economy is calibrated to Indonesia, while the Foreign block is interpreted as a stylized representation of major external trading partners. Core structural parameters follow standard New Keynesian values where possible: the discount factor is set to $\beta = 0.99$, the capital share to $\nu = 0.33$, depreciation to $\delta = 0.025$, and the investment adjustment cost parameter to $\varphi = 4$ following Christiano et al. (2005). The steady-state inflation target is set to the Bank Indonesia target midpoint, annualized at 3 percent, while trend productivity growth is calibrated at 4.5 percent annually.

The parameters most directly related to the paper's mechanism are calibrated to match the strength of trade exposure, GSCP volatility, and policy-state dependence. Home import intensity is set to $\omega_{nx,H} = 0.25$, while the baseline trade-vulnerability parameter is $\phi_{nx,H} = 0.20$ and is varied in the sensitivity experiments. The imported-input cost share is set to $\xi_{m,H} = 0.25$, so that delivered import prices enter marginal costs with a quantitatively meaningful elasticity. The GSCP process is calibrated using the empirical GSCPI-based series over Q1 2008-Q2 2025. Consistent with the LP analysis, the baseline empirical shock is constructed as the standardized residual from an AR-X specification of the GSCPI, controlling for GSCPI persistence, seasonally adjusted world industrial production, and the VIX, with lag length selected by BIC over one to four lags. For the

DSGE calibration, the external supply-chain disturbance is summarized by a parsimonious AR(1) process,

$$z_t^{\text{gscp}} = \rho_{\text{gscp}} z_{t-1}^{\text{gscp}} + \varepsilon_t^{\text{gscp}}, \quad \varepsilon_t^{\text{gscp}} \sim N(0, \sigma^2_{z^{\text{gscp}}}),$$

where ρ_{gscp} governs shock persistence and $\sigma_{z^{\text{gscp}}}$ governs innovation volatility. The persistence parameter is set to $\rho_{z^{gscp}} = 0.8562$, based on the empirical persistence of GSCPI dynamics, while the shock size is scaled to match the magnitude of the standardized GSCPI-based innovation used in the LP analysis. Shock volatility switches between low- and high-volatility regimes, with the high-volatility standard deviation set to twice the low-volatility value. Monetary policy in the Home economy switches between hawkish and dovish regimes, with $\psi^H = 3.5$ and $\psi^D = 1.5$, respectively. These values are not intended to estimate Indonesia's historical policy regimes directly; rather, they provide counterfactual regimes for examining how the strength of the inflation response shapes GSCP shock transmission. Throughout the remainder of this section, all quantitative statements refer to model-simulated responses under this calibration; comparisons with the LP evidence are explicitly flagged where made. Figures 8-11 report impulse responses from the nonlinear two-country DSGE model under this calibration.[6]

Figure 8 illustrates the role of monetary policy stance under a high-vulnerability calibration. A GSCP shock raises import prices and marginal costs, generating inflationary pressure and a contraction in output, consumption, and investment. This creates a policy trade-off because the shock has both inflationary and contractionary effects: tightening policy can help contain inflation persistence and second-round effects, but it may also reinforce the decline in real activity. This finding is consistent with the standard monetary-policy implication that central banks respond more aggressively to demand-driven inflation than to supply-driven inflation when inflation expectations remain anchored (Erceg et al., 2000; Bodenstein et al., 2008), as well as recent evidence that policy responses tend to differ depending on whether inflation is driven by supply or demand factors (Hofmann et al., 2024).

Figure 9 varies the trade-vulnerability parameter rather than the trade-openness parameter because the main DSGE mechanism of interest is imported-cost pass-through. In the model, a higher value of $\phi_{nx,H}$ directly raises the sensitivity of delivered import prices and marginal costs to a GSCP shock. This produces a clearer inflationary amplification mechanism. By contrast, changing $\omega_{nx,H}$ would mainly alter import intensity, external exposure, and the net-export response. Such an exercise would be useful for studying external adjustment, but it is less directly tied to the inflation

[6] A caveat on scope is warranted. The DSGE model is calibrated to Indonesia, whereas the LP estimates pool evidence across the ASEAN-5 economies. This creates an interpretive asymmetry: structural parameters such as $\omega_{nx,H}$, $\phi_{nx,H}$, and the Taylor-rule coefficients reflect Indonesia's trade structure and monetary policy calibration, which may differ substantially from other economies in the panel. For example, Singapore operates as a trading hub with much higher trade intensity, while Malaysia and Thailand are more deeply embedded in regional manufacturing supply chains than Indonesia. The DSGE model should therefore be interpreted as a stylized structural mechanism rather than a quantitatively precise representation of the ASEAN-5 panel-average response. A fully heterogeneous calibration is left for future work.

pass-through channel emphasized in this paper. For this reason, the reported DSGE sensitivity exercise focuses on vulnerability, while stochastic or time-varying trade exposure is left for future work.

The responses also differ across policy regimes. In the simulations, the dovish regime is associated with a larger and more persistent inflation response, as marginal costs remain elevated for longer and imported-cost pressures pass through more gradually into prices. Under the hawkish regime, the stronger policy-rate response is associated with smaller and less persistent increases in inflation and marginal costs. However, this should not be interpreted as implying that hawkish policy is unambiguously preferable. The original shock operates through imported-input costs and supply-side constraints, so tighter policy cannot directly remove the source of the disruption and may still be associated with weaker real activity. The model therefore illustrates a stabilization trade-off: stronger monetary policy can reduce inflation persistence and second-round price pressures, but it does not eliminate the real-side costs of GSCP shocks. This result should be interpreted as a persistence mechanism rather than direct evidence of a wage-price spiral or expectations de-anchoring channel, which are not separately identified in the model.

Figure 9 focuses on the role of trade vulnerability under a hawkish monetary policy regime. The comparison between $\phi_{nx} = 0.2$ and $\phi_{nx} = 0.9$ indicates that higher vulnerability amplifies the transmission of GSCP shocks. Import prices and marginal costs rise stronger when ϕ_{nx} is high, producing a larger inflation response and a deeper contraction in real activity. Output, consumption, and investment all decline more under the high-vulnerability calibration, with investment showing the most pronounced adjustment. This result reflects the model's imported-input cost channel: when the economy is more vulnerable to global logistics disruptions, the same external shock produces a larger increase in delivered import prices and marginal costs, and a stronger decline in domestic absorption. The mechanism is consistent with evidence that global supply-chain pressures transmit to inflation through international production networks, imported inputs, and cost pass-through rather than through aggregate trade exposure (di Giovanni et al., 2022; Gordon and Clark, 2023; Chau et al., 2024). In this sense, ϕ_{nx} captures the structural sensitivity of marginal costs to global supply disruptions, helping in explaining why economies with similar degrees of openness may experience different inflation and output responses.

External-sector responses also vary across vulnerability calibrations. Under higher trade vulnerability, net exports rise higher after the shock, while the exchange-rate response is larger and more persistent. The improvement in net exports can be interpreted as reflecting import compression and weaker domestic absorption following the cost shock, rather than an unambiguously favorable external adjustment. This interpretation is in line with evidence that import compression can mechanically improve the trade balance but may weaken production and export capacity when imports include intermediate and capital goods (Khan and Knight, 1988). In economies integrated into global value chains, exchange-rate and trade-balance adjustments are further shaped by imported-input dependence, because imported inputs affect firms' cost structures, pricing decisions, and the responsiveness of trade volumes to exchange-rate movements (Amiti et al., 2014; Adler et al., 2019). Thus, the external improvement in the model occurs alongside weaker output, consumption, and investment, suggesting that the trade-balance response is driven at least in part by demand compression rather than stronger productive capacity. Under lower vulnerability, external adjustment seems more muted because imported-cost pass-through is weaker and domestic activity is less affected.

Figure 10 brings together the three key dimensions: monetary policy stance, GSCP shock volatility, and trade vulnerability. The results reveal a state-dependent amplification mechanism. Across variables, the largest responses occur when high trade vulnerability coincides with a dovish policy stance and a high-volatility GSCP regime. In this case, output, consumption, and investment fall the most, while inflation, marginal costs, import prices, and the policy-rate response display the largest deviations from steady state. By contrast, responses are smallest when vulnerability and volatility are low and policy is hawkish. This interaction is consistent with the broader view that the macroeconomic consequences of supply shocks depend not only on the shock itself, but also on production-network structure and imported-cost pass-through (di Giovanni et al., 2022; Gordon and Clark, 2023).

The policy dimension is central to this amplification mechanism, but the interpretation is conditional rather than normative. For a given vulnerability and volatility regime, a weaker response to inflation allows imported-cost pressures to pass through more persistently into marginal costs and prices. A stronger response can dampen this persistence, but it does not directly relax imported-input bottlenecks or remove the supply-side origin of the shock. The comparison between dovish and hawkish regimes should therefore be read as a model-based stabilization trade-off rather than as a general ranking of policy stances. This mechanism is consistent with standard monetary-policy theory, which emphasizes that the appropriate response to inflation depends on the source of the shock and the trade-off between stabilizing inflation and real activity (Erceg et al., 2000; Bodenstein et al., 2008). It is also consistent with policy-oriented evidence that monetary policy responses differ depending on whether inflation is driven by supply or demand factors (Hofmann et al., 2024). Furthermore, the simulations suggest that monetary policy can dampen inflationary propagation, but its stabilizing capacity is constrained when inflation originates from imported input costs and when trade vulnerability is high.

The volatility regime provides an additional source of amplification. High-volatility GSCP regimes generate larger and more persistent responses than low-volatility regimes, especially for inflation, marginal costs, investment, net exports, and the exchange rate. In the simulations, high volatility not only increases the size of the shock but is also associated with a slower return toward steady state. This is especially visible in the full interaction figure, where high-volatility responses remain separated from low-volatility responses over much of the horizon. The implication is that global supply disruptions generate larger macroeconomic costs when they occur under already unstable global logistics conditions. This is broadly consistent with evidence that global supply-chain pressures can have persistent inflationary effects and that monetary policy challenges become more pronounced when supply-chain stress is elevated (Andriantomanga et al., 2023; Hernández et al., 2024).

Figure 11 highlights the external adjustment mechanism. The most pronounced external-sector responses occur under the dovish, high-vulnerability, high-volatility configuration. This pattern is consistent with the real-side contraction documented in the broader IRFs: the rise in imported input costs compresses domestic absorption and import demand, while exchange-rate movements and relative activity effects support a temporary improvement in net exports. Nevertheless, the improvement in net exports does not offset the domestic cost of the shock, as it occurs together with lower output, weaker consumption, and a sharp contraction in investment. This interpretation is consistent with evidence that import compression can mechanically improve the trade balance while weakening production when imports include intermediate and capital goods, and that global value-chain integration can alter the responsiveness of trade flows and prices to exchange-rate movements (Khan and Knight, 1988; Amiti et al., 2014; Adler et al., 2019).

The DSGE simulations provide a structural interpretation of the LP evidence and extend it by showing how monetary policy stance shapes the propagation of global supply-chain shocks. The results are consistent with the empirical finding that GSCP shocks generate delayed, hump-shaped inflation responses and that trade vulnerability plays a more visible role than trade openness by itself in the point estimates. The model further shows that this transmission is nonlinear: structural vulnerability amplifies imported-cost pass-through, high-volatility regimes magnify and prolong the adjustment, and monetary policy stance affects the persistence of inflationary pressures. These findings point to a central implication: the inflationary consequences of global supply disruptions depend jointly on structural exposure, the volatility of global supply conditions, and the stance of monetary policy. This implication should be interpreted through the lens of policy trade-offs, since monetary tightening may reduce inflation persistence but cannot directly resolve supply-chain disruptions and may entail real-activity costs.

4 Concluding Remarks

This paper studies how global supply-chain disruptions transmit to domestic inflation and how this transmission depends on trade vulnerability, shock-volatility regimes, and monetary policy stance. Using a panel LP framework for ASEAN-5 economies complemented by a nonlinear two-country NK-DSGE model calibrated to Indonesian economy, the analysis provides both reduced-form evidence and a structural interpretation of the inflationary effects of GSCP shocks. The empirical analysis focuses on ASEAN-5 economies, while the DSGE model provides a stylized mechanism for interpreting the transmission channels, with particular attention to imported-input costs, external adjustment, volatility regimes, and hawkish versus dovish monetary policy responses.

The empirical evidence highlights the importance of distinguishing trade openness from structural trade vulnerability. GSCP shocks generate delayed and hump-shaped inflation responses, with economically meaningful effects emerging at medium horizons. Trade openness on its own does not systematically amplify inflationary pressures once domestic and global controls are considered; the interaction between openness and the GSCP shock is small and statistically indistinguishable from zero across specifications. By contrast, the point estimates suggest that economies with greater exposure to disruptions in global value chains experience stronger and more persistent inflationary responses to the same GSCP shock, particularly during periods of elevated global trade volatility, although these interaction effects are estimated with uncertainty.

The DSGE model clarifies the mechanisms underlying these findings by distinguishing the roles of trade openness, structural vulnerability, global volatility regimes, and monetary policy stance in shaping the transmission of global supply-chain disruptions. In the model, trade openness primarily affects quantities and external adjustment through import intensity and leakage, whereas vulnerability governs the pass-through of global logistics stress into delivered import prices and firms' marginal costs. Higher imported-input costs raise marginal costs, induce endogenous policy-rate responses, and dampen output, consumption, and investment, producing stagflationary dynamics. This distinction is consistent with the empirical finding that openness by itself does not systematically amplify inflation, while the point estimates suggest that higher vulnerability is associated with stronger inflationary responses to GSCP shocks. The regime-switching structure introduces state dependence: in low-volatility regimes, GSCP shocks generate smaller and more contained responses, whereas in high-volatility regimes the same shock produces larger and more persistent increases in marginal costs and inflation, reflecting amplification when global logistics conditions are already strained.

The simulations further highlight broader macroeconomic adjustments that are less visible in the reduced-form estimates. The hawkish-dovish extension shows that monetary policy stance materially affects the propagation of these shocks, but the comparison should be interpreted as a stabilization trade-off rather than as a general ranking of policy regimes. A weaker policy response is associated with more persistent pass-through from imported costs to inflation, while a stronger policy response dampens inflation and marginal-cost persistence. However, tighter policy cannot directly remove imported-input bottlenecks or the supply-side origin of the shock, and it does not fully offset the contractionary consequences when trade vulnerability is high or when global supply-chain volatility is elevated. These results suggest that monetary policy can condition the transmission of external cost shocks, but its stabilizing capacity is constrained by structural exposure to imported inputs, the volatility of global supply conditions, and the real-activity costs associated with responding to supply-driven inflation.

External-sector responses, including import contraction, exchange-rate adjustment, and net-export movements, are also shaped by the vulnerability calibration, the volatility regime, and policy stance. In the model, net exports may improve temporarily following a GSCP shock, but this adjustment reflects weaker domestic absorption and import compression rather than a favorable expansion in productive capacity. The broad consistency between the LP evidence on inflation dynamics and the model-based impulse responses suggests that the structural channels embedded in the DSGE framework offer a plausible interpretation of the empirical findings. The results further indicate that the inflationary consequences of global supply disruptions depend on deeper structural features of production networks and policy regimes, not merely on trade intensity.

Several caveats should be noted. First, the DSGE framework is calibrated rather than formally estimated. This approach helps maintain transparency and keeps the structural simulations closely aligned with the empirical local-projection evidence, but formal estimation would allow a more systematic assessment of parameter uncertainty, shock dynamics, and regime-switching probabilities. Second, the DSGE model is calibrated to Indonesia, whereas the empirical LP analysis pools evidence across ASEAN-5 economies. Indonesia is used as a small-open-economy benchmark with meaningful exposure to global supply-chain pressures, but without the extremely high openness and trade-hub characteristics of Singapore. The structural model should therefore be interpreted as a stylized mechanism for understanding imported-input cost pass-through and policy trade-offs, rather than as a quantitative representation of the ASEAN-5 panel-average response. A fully heterogeneous calibration across ASEAN-5 economies would allow richer cross-country comparisons, particularly given differences in production networks, trade structures, import dependence, and monetary policy frameworks.

In addition, the trade-vulnerability parameter, ϕ_{nx}, is specified in a reduced-form way. It serves as a tractable proxy for structural exposure to global production networks–including reliance on imported intermediate inputs, supplier concentration, and logistics frictions–but a richer microfounded treatment could better capture how these channels operate in specific country settings. Similarly, the hawkish and dovish monetary policy regimes are introduced as counterfactual policy stances rather than empirically estimated regimes or policy prescriptions. Future work could estimate policy-regime probabilities jointly with supply-chain shocks and allow policy credibility, exchange-rate concerns, financial conditions, and policy-objective trade-offs to interact more explicitly with imported-cost shocks. Such extensions would strengthen the model's relevance for policy analysis in an environment where external supply disruptions, global volatility, and domestic policy responses jointly shape inflation dynamics.

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A Appendix: Construction of the Global Trade Vulnerability Index (GTVI)

This appendix documents the procedure used to construct the country-level Global Trade Vulnerability Index (GTVI) used in the LP estimation.[7] The GTVI is extracted as the first time-varying common factor from a large set of economic indicators that proxy the country's exposure and sensitivity to global fragmentation and supply-chain pressure. The methodology follows a Time-Varying Parameter Factor-Augmented Vector Autoregression (TVP-FAVAR) based on Koop and Korobilis (2013) and the dynamic factor approach of Doz et al. (2011).

A.1 Data preparation

We compile quarterly data from CEIC. The variables include external trade indicators, GVC-related measures, financial exposures, and domestic macroeconomic indicators. The treatment of the raw data proceeds in three stages:

1. **Seasonal Adjustment.** All series are seasonally adjusted in levels using the SEATS procedure from the X-13ARIMA-SEATS framework. For each variable x_t, the raw series is passed to the SEATS decomposition, which applies an ARIMA-based model-based seasonal filter, rather than simple deterministic quarterly dummies, and returns the seasonally adjusted component,

$$\tilde{x}_t = x_t^{\text{SA, SEATS}},$$

   where the seasonal pattern is removed through the signal extraction algorithm described in Burman (1980) and Dagum and Bianconcini (2016). The advantage of SEATS over deterministic regressions is that the seasonal pattern is allowed to vary stochastically over time and is jointly estimated with the ARIMA model for the underlying series. The SEATS-adjusted $\tilde{x}_t$ is then used as the input for subsequent stationarity testing and transformations. The seasonal adjustment was implemented via the X-13 Toolbox for seasonal filtering (Lengwiler, 2025), which interfaces with the U.S. Census Bureau's X-13ARIMA-SEATS software for SEATS decomposition (U.S. Census Bureau, 2020).

2. **Stationarity Transformation.** Each seasonally adjusted variable is tested for a unit root using the augmented Dickey-Fuller (ADF) test. If the series is non-stationary:

   (a) for indicators measured in percent or diffusion indices, we take *first differences*,

$$\Delta x_t = x_t - x_{t-1};$$

[7] Indonesia is used as an illustrative example.

(b) for non-percent variables, we take log differences when the level is strictly positive,

$$\Delta x_t = 100 \times (\log x_t - \log x_{t-1}),$$

otherwise we use first differences.

Stationary series are kept in levels.

3. **Alignment, Imputation, and Standardization.** After transformation, all series are aligned to the available sample. Missing interior values are filled using forward- and backward-replacement for numerical stability. Finally, all variables are standardized:

$$z_{i,t} = \frac{x_{i,t} - \bar{x}_i}{s_i}.$$

Let the resulting balanced dataset be the $T \times N$ standardized panel Z_t.

A.2 Model specification: TVP-FAVAR

We partition the set of observable variables into

$$Y_t = (y_{1,t}, y_{2,t}, y_{3,t})' \quad \text{(macro block)},$$

and

$$X_t = Z_t \setminus Y_t \quad \text{(GVC and financial exposure block)}.$$

The goal is to extract a latent factor that summarizes the country's vulnerability to global supply-chain pressure and trade-fragmentation risks.

The measurement equation is

$$\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \Lambda_t \begin{pmatrix} Y_t \\ F_t \end{pmatrix} + e_t, \tag{40}$$

where F_t is the latent factor, interpreted as the GTVI, Λ_t denotes time-varying factor loadings, and $e_t \sim N(0, V_t)$.

The state equation for the factor-augmented VAR is

$$\begin{pmatrix} Y_t \\ F_t \end{pmatrix} = B_t \begin{pmatrix} Y_{t-1} \\ F_{t-1} \end{pmatrix} + u_t, \tag{41}$$

where $u_t \sim N(0, Q_t)$ and the VAR coefficients evolve according to a random walk:

$$B_t = B_{t-1} + \nu_t, \qquad \Lambda_t = \Lambda_{t-1} + \eta_t.$$

The stochastic volatilities V_t and Q_t follow exponentially weighted moving-average (EWMA) updating rules governed by forgetting factors $\ell_1, \ell_2, \ell_3, \ell_4$.

A.3 Estimation

Estimation proceeds in three steps:

1. **Initialization via PCA.** Principal components of X_t provide initial estimates of the latent factors, F_t^{PC}, and associated loadings, Λ^{PC}.

2. **Static and Quasi-Dynamic Factor Estimates.** We obtain the Doz et al. (2011) estimates by applying a Kalman filter and smoother with fixed loadings and covariance parameters initialized from PCA.

3. **TVP-FAVAR Estimation.** The dynamic factor structure is estimated using the time-varying parameter FAVAR framework of Koop and Korobilis (2013), implemented with the original MATLAB routines made available by Dimitris Korobilis.[8] For each period t, the measurement loadings Λ_t, VAR coefficient matrices B_t, idiosyncratic error covariance V_t, and factor shock covariance Q_t evolve according to random-walk state equations with exponentially weighted moving-average innovations.

   Given $(\Lambda_t, B_t, V_t, Q_t)$, the latent factor sequence F_t is extracted using a Kalman smoother. Parameters and factors are updated iteratively until convergence. The Global Trade Vulnerability Index is defined as the first estimated factor:

$$\mathrm{GTVI}_t \equiv F_t.$$

To ensure consistent orientation, the sign of F_t is chosen such that its correlation with a reference exposure variable, such as short-term external debt of banks, is positive. Finally, the GTVI is standardized to have mean zero and unit variance.

A.4 Interpretation

The GTVI summarizes how a country's macro-financial system comoves with GVC-sensitive variables and external exposure indicators in a time-varying framework. Higher values indicate periods in which the country appears more exposed to global supply-chain fragmentation, external shocks, or policy-driven trade pressures. Because the loadings and VAR coefficients evolve over time, the GTVI is designed to reflect changes in a country's integration with global value chains and sensitivity to external trade-related risks.

[8] The code used for TVP-FAVAR estimation, including functions for Kalman filtering, smoothing, and time-varying covariance updates, is available at https://sites.google.com/site/dimitriskorobilis/matlab/forecasting-tvp-favar.

A.5 Example: Developing a GTVI for Indonesia

The construction of the GTVI is described in detail in this section, while the underlying variables are summarized in Table 1. As shown in Figure 1, the index exhibits large movements during the global financial crisis and the COVID-19 pandemic.

A.5.1 Variables and data

The construction of Indonesia's Global Trade Vulnerability Index uses a broad set of macroeconomic, external, real-sector, and financial variables that together capture multiple channels through which global fragmentation pressures may affect the domestic economy. Indonesia's vulnerability is multi-dimensional: it reflects not only direct trade exposure to major partners such as China and the United States, but also the structure of its manufacturing base, reliance on imported intermediate goods, external financing conditions, and sensitivity to global uncertainty or supply-chain disruptions. By combining these indicators into a single composite factor using data-driven statistical methods, the GTVI summarizes a common cyclical component associated with Indonesia's exposure to global trade risks over time.

Trade indicators form a central component of the GTVI. The export share to China and import share sourced from China measure the economy's bilateral economic dependence, which is relevant given China's role as a key export market for natural resources and a critical supplier of industrial inputs. Imports of raw materials and intermediate goods provide a more structural measure of Indonesia's participation in global value chains, where disruptions to cross-border production networks can affect domestic manufacturing output. These trade-side indicators allow the GTVI to reflect both the scale and composition of Indonesia's external linkages.

Alongside trade exposure, the GTVI incorporates indicators of financial and external resilience. Short-term external debt of the banking sector captures rollover risk and vulnerability to shifts in global risk sentiment. Foreign exchange reserves, measured in months of import coverage, provide information on the economy's capacity to absorb external shocks, while the current account balance captures external funding needs. Movements in the real effective exchange rate (REER) capture competitiveness pressures and the impact of global monetary conditions. Together, these variables summarize macro-financial channels through which global fragmentation may affect domestic liquidity, exchange-rate conditions, and financial stability.

Real-sector indicators, including manufacturing value added and industrial production indices for GVC-intensive subsectors such as electrical machinery, machinery and equipment, chemicals, and basic metals, help the GTVI reflect the structure of Indonesia's production network. These industries rely heavily on foreign inputs and multinational supply chains; thus, fluctuations in their activity may provide information about external supply disruptions or policy-driven fragmentation. Including these variables strengthens the GTVI's ability to capture real-economy manifestations of global shocks.

Global uncertainty indicators further enrich the index. The GSCPI captures logistics bottlenecks and transportation disruptions, while the Trade Policy Uncertainty Indices (TPUI) for China and the United States reflect uncertainty associated with tariff policy, export controls, and geopolitical tensions. Incorporating these measures allows the "with-global-indices" version of the GTVI to reflect external sources of uncertainty more directly. A parallel version of the index excluding these global variables provides a robustness check by isolating the contribution of Indonesia's own structural conditions.

The final GTVI is generated using three alternative factor-extraction approaches: (i) static principal components analysis (PCA); (ii) the quasi-dynamic factor model of Doz et al. (2011), which adjusts the PCA-based factor estimates for measurement error and serial correlation; and (iii) a fully time-varying parameter FAVAR model following Koop and Korobilis (2013), which allows factor loadings and shock transmission mechanisms to evolve over time. The three approaches produce broadly similar GTVI series, suggesting that the extracted vulnerability signal is not driven by a single factor-extraction method.

A.5.2 Results and discussion

Figure 1 shows that Indonesia's GTVI is countercyclical and responsive to global stress episodes. Large deteriorations are observed during the 2008-2009 global financial crisis and again during the onset of the COVID-19 pandemic in early 2020, when all three GTVI versions exhibit sharp and synchronized declines. These episodes coincide with broad-based global disruptions that affected trade flows, manufacturing supply chains, external financing conditions, and global uncertainty.

During 2014-2019, the GTVI exhibits relatively moderate fluctuations, consistent with a period of macroeconomic consolidation and more stable external conditions, aside from intermittent U.S.-China trade tensions. Beginning in 2017, marked in the figure as the first Trump administration, the GTVI gradually rises, consistent with heightened global trade-policy uncertainty and disruptions to technology and supply-chain linkages. This pattern intensifies in 2018-2019 as trade tensions escalate.

In the post-pandemic recovery period from 2021 to 2023, the GTVI improves but remains more volatile than in the pre-COVID period. While domestic activity recovered, global supply-chain pressure, commodity price swings, and shifting monetary conditions contributed to continued vulnerability. By 2024-2025, the GTVI stabilizes but remains above its pre-2018 levels, suggesting that Indonesia may continue to face elevated exposure to global fragmentation dynamics.

In summary, the GTVI provides a tractable empirical summary of Indonesia's exposure to global trade pressures. By combining variables representing trade dependencies, GVC integration, external financing conditions, real-sector sensitivity, and global uncertainty, the index summarizes multiple channels through which external trade and supply-chain risks may affect the domestic economy. The convergence of PCA, Doz et al. (2011) factor, and TVP-FAVAR estimates suggests that the extracted vulnerability signal is not driven by a single factor-extraction method and may be useful for macroeconomic surveillance and scenario analysis.

Table 1: Variables Used in Constructing the Global Trade Vulnerability Index (GTVI), Indonesia

Variable	Unit	Description
Real GDP	IDR billion	Gross domestic product, constant prices.
GDP deflator	Index	GDP deflator index.
Short-term interest rate	Percent (% p.a.)	Monetary policy rate (quarterly average).
Exports to China/Total exports	Percent (%)	Share of total exports to China.
Imports from China/Total imports	Percent (%)	Share of total imports from China.
Imports: raw materials and intermediates	USD million	Imports of raw and intermediate inputs used in domestic production.
FX reserves	Months	International reserves measured in months of import coverage.
Current account balance	Percent of GDP	Current account surplus/deficit relative to GDP.
Real effective exchange rate (REER)	Index	Real effective exchange rate; an increase indicates real appreciation.
Import price index (USD)	Index	Index of import prices denominated in USD.
GDP manufacturing industry	IDR billion	Gross value added of Indonesia's manufacturing sector.
IPI: electrical machinery	Index	Industrial production index for electrical machinery and equipment.
IPI: machinery and equipment	Index	Industrial production index for machinery and equipment.
IPI: chemicals	Index	Industrial production index for chemical products.
IPI: basic metals	Index	Industrial production index for basic metal manufacturing.
Exports: non-oil and gas	USD million	Exports of non-oil and gas goods.
Exports: manufactured products	USD million	Exports of manufactured goods.
GSCPI	Index	Capturing bottlenecks and shipping constraints.
TPUI China	Index	Trade Policy Uncertainty Index of China.
TPUI US	Index	Trade Policy Uncertainty Index of the United States.

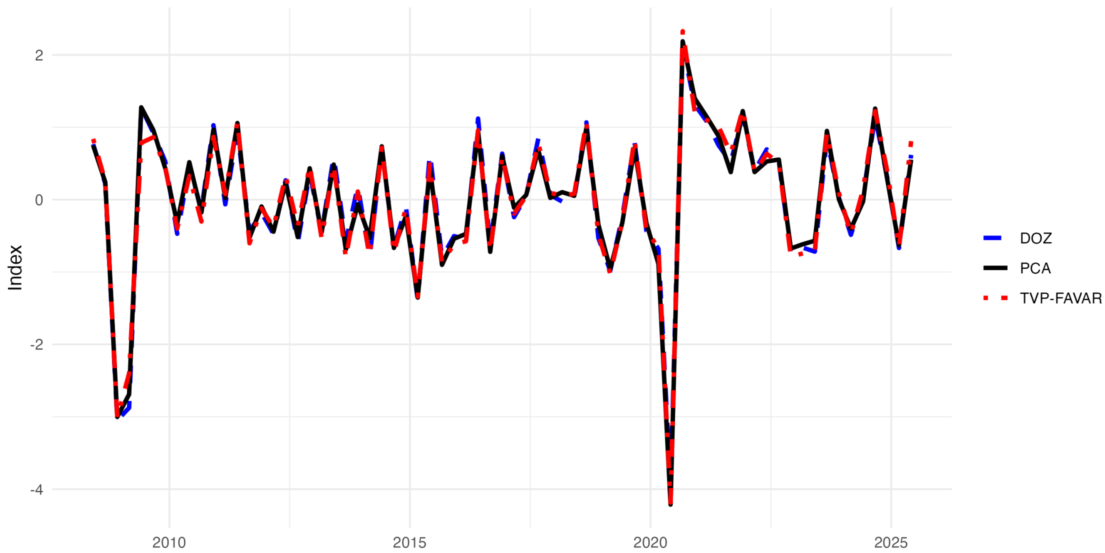

Figure 1: Global Trade Vulnerability Index (GTVI), Indonesia

Notes: The figure compares three alternative estimates of the global trade vulnerability index (GTVI) for Indonesia: a static principal components analysis (PCA) estimate, the dynamic factor estimate of Doz et al. (2011), and the time-varying parameter factor-augmented vector autoregression (TVP-FAVAR) estimate of Koop and Korobilis (2013). The static PCA series is constructed as the first principal component of the standardized data matrix. The Doz et al. (2011) series is obtained using a quasi-maximum likelihood dynamic factor model estimated with a Kalman smoother. The TVP-FAVAR series follows the time-varying parameter framework of Koop and Korobilis (2013). All indices are standardized to have mean zero and unit variance.

Table 2: Time-series diagnostics for trade vulnerability

Country	Rolling volatility (12)			Extreme episodes		Persistence (AR(1))		
	Avg. SD	Med. SD	Max. SD	Share < -1.5	Lgst. run	ρ	SD(ε)	R^2
Indonesia	0.89	0.70	1.67	0.04	2	0.02	1.00	0.00
Singapore	0.88	0.81	1.53	0.09	2	0.24	0.98	0.06
Thailand	0.71	0.67	1.40	0.07	3	0.51	0.87	0.25
Malaysia	0.63	0.56	1.36	0.06	2	0.57	0.83	0.32
Philippines	0.39	0.27	0.92	0.09	5	0.93	0.40	0.84

Notes: Rolling volatility is computed using a 12-quarter window. Extreme episodes refer to observations below -1.5 in the standardized vulnerability series, and "Lgst. run" denotes the longest consecutive run of such observations. Persistence is estimated using a country-specific AR(1) regression of the vulnerability index, where ρ is the estimated autoregressive coefficient, SD(ε) is the standard deviation of the AR(1) residual, and R^2 is the regression fit.

Table 3: Correlation between trade vulnerability, openness, and global supply-chain stress

Country	Openness		GSCPI		GSCP shock		GSCPI vol.	
	P	S	P	S	P	S	P	S
Indonesia	0.053	0.034	0.171	0.299	-0.051	0.126	0.184	0.236
Malaysia	-0.205	-0.244	0.337	0.367	0.020	0.029	0.485	0.497
Philippines	0.586	0.560	0.322	0.281	-0.056	-0.039	0.369	0.338
Singapore	-0.109	-0.044	0.321	0.342	0.096	0.155	0.283	0.244
Thailand	-0.028	-0.043	0.315	0.344	0.033	0.001	0.219	0.231
Pooled raw	-0.005	0.020	0.293	0.332	0.009	0.063	0.308	0.315
Pooled within-country	-0.030	0.012	0.293	0.330	0.009	0.063	0.308	0.314

Notes: P and S denote Pearson and Spearman correlations, respectively. The table reports correlations between the time-varying trade vulnerability index (GTVI), trade openness, the Global Supply Chain Pressure Index (GSCPI), the estimated standardized GSCP shock, and rolling volatility of GSCPI innovations. Country-level correlations are based on 69 quarterly observations for each economy. Pooled correlations are based on 345 observations. The pooled within-country correlations are computed after removing country-specific means from each variable. GSCPI volatility is measured using the rolling standard deviation of the estimated GSCPI innovation.

Table 4: Summary of LP robustness checks

Robustness check	Main GSCP shock resp.	Openness interaction	GTVI interaction
Excluding Singapore	Remains visible; response becomes more front-loaded in some specifications	Remains weak and imprecisely estimated	Remains more visible than openness in the point estimates
Leave-one-country-out	Remains positive and hump-shaped across all country exclusions, with the peak response consistently around horizon 3	Remains small and less stable across exclusions	Remains positive over medium horizons across all exclusions, although magnitude and significance vary
Wild-cluster bootstrap	Delayed response remains significant at horizons 2-4, with the peak around horizon 3	No sustained medium-horizon amplification; positive at short horizons but negative at longer horizons	Positive at selected medium horizons, though the horizon-by-horizon path is less smooth
COVID-period dummy	Broadly similar but less stable across horizons	No systematic amplification	Still more visible than openness, though estimated with uncertainty
Excluding COVID period	Weaker and less stable, consistent with reduced GSCP variation	No systematic amplification	Some positive medium-horizon responses remain, but less precisely estimated
Alternative volatility threshold	Regime separation becomes less precise under a stricter p75 threshold	No sustained amplification	Positive at selected horizons but less stable and less precisely estimated
Standardized ΔGSCPI shock	Less stable than the baseline AR-X shock, but medium-horizon responses remain visible in some specifications	Remains weak and does not show systematic amplification	Positive medium-horizon responses remain visible, especially in richer specifications

Notes: The Singapore-exclusion, leave-one-country-out, COVID-dummy, and COVID-exclusion checks use the baseline GSCP shock, constructed as the standardized residual from an AR-X specification of the GSCPI. The AR-X specification controls for GSCPI persistence, seasonally adjusted world industrial production, and the VIX, with lag length selected by BIC over one to four lags. The standardized ΔGSCPI check instead uses the standardized first difference of the GSCPI as a model-light alternative shock construction that does not rely on estimating a first-stage AR/AR-X residual equation. The Singapore-exclusion check removes the trade-hub economy with the most extreme openness ratio. The leave-one-country-out check re-estimates the preferred specification by excluding one ASEAN-5 economy at a time and should be interpreted as a small-panel sensitivity exercise rather than as a formal jackknife standard-error correction. The COVID-dummy specification preserves pandemic-era GSCP variation while allowing for a crisis-period level shift. The COVID-exclusion check removes the pandemic period and is therefore interpreted as a stricter sensitivity exercise rather than as the preferred specification. GTVI denotes the Global Trade Vulnerability Index.

Table 5: DSGE calibration for Indonesia

Param.	Value	Interpretation	Source/Basis
Core structural parameters			
β	0.99	Discount factor	Standard; implies approximately 4% annual real rate
π^*	$1.03^{1/4}$	Inflation target	Bank Indonesia target midpoint, annualized at 3%
μ	$1.045^{1/4}$	Trend productivity growth	BPS data; annualized at 4.5%
η	6	Elasticity of substitution	Standard NK calibration; markup $\approx 20\%$
κ	60	Rotemberg adjustment cost	Calibrated; NKPC slope ≈ 0.083
α	0.5	Inflation indexation	Calibrated
ν	0.33	Capital share	Standard / Penn World Tables
δ	0.025	Depreciation rate	Standard; 10% annualized
φ	4	Investment adjustment cost	Christiano et al. (2005)
Monetary policy regimes			
ρ	0.75	Home interest-rate smoothing	Calibrated
ψ^H	3.5	Home inflation response, hawkish regime	Calibrated
ψ^D	1.5	Home inflation response, dovish regime	Calibrated
p^{mp}_{HD}	0.10	Hawkish-to-dovish transition probability	Calibrated
p^{mp}_{DH}	0.10	Dovish-to-hawkish transition probability	Calibrated
ρ_F, ψ_F	$0.85,\ 1.50$	Foreign policy smoothing and inflation response	Calibrated
Trade, vulnerability, and GSCP			
$\omega_{nx,H}$	0.25	Home import intensity	Indonesia imports-to-GDP calibration
$\phi_{nx,H}$	0.20	Home trade vulnerability, baseline	Varied in sensitivity experiments
$\xi_{m,H}$	0.25	Home imported-input cost share	Indonesia input-cost exposure calibration
$\omega_{nx,F}, \phi_{nx,F}$	$0.15,\ 0.20$	Foreign trade block parameters	Calibrated
$\xi_{m,F}$	0.12	Foreign trade block parameters	Calibrated
λ_{leak}	0.20	Leakage/absorption strength	Calibrated
$\rho_{z^{gscp}}$	0.8562	GSCP persistence	Estimated AR(1) on GSCPI, Q1 2008-Q2 2025
γ_{ship}	0.06	GSCP to import-price wedge	Calibrated
ϑ_ϕ	2	Vulnerability convexity	Calibrated
$\sigma^L_{zgscp}, \sigma^H_{zgscp}$	$0.58,\ 1.16$	GSCP shock volatility, low and high regimes	Calibrated; high volatility is $2\times$ low volatility
$p^{gscp}_{LH}, p^{gscp}_{HL}$	$0.05,\ 0.50$	GSCP volatility transition probabilities	Calibrated
External block and other shocks			
ρ_s, ϕ_s	$0.80,\ 0.15$	Exchange-rate persistence and interest-rate differential effect	Calibrated
ρ_q, σ_q	$0.70,\ 0.01$	Risk-premium persistence and shock volatility	Calibrated
ρ_z, σ_z	$0.75,\ 0.01$	Technology shock persistence and volatility	Standard
ρ_η, σ_η	$0.75,\ 0.01$	Cost-push shock persistence and volatility	Standard
σ_r	0.54	Monetary policy shock standard deviation	Calibrated

Notes: All parameters are at quarterly frequency. The Home economy is calibrated to Indonesia, while the Foreign block represents major external trading partners. Monetary policy in the Home economy switches between hawkish and dovish regimes, with $\psi^H > \psi^D$. GSCP shock volatility also switches between low- and high-volatility regimes, with $\sigma^L_{zgscp} < \sigma^H_{zgscp}$. The monetary policy regime s^{mp}_t is distinct from the GSCP volatility regime s^{gscp}_t, allowing policy stance and external uncertainty to evolve independently. The baseline value of $\phi_{nx,H}$ is varied in the sensitivity and regime experiments.

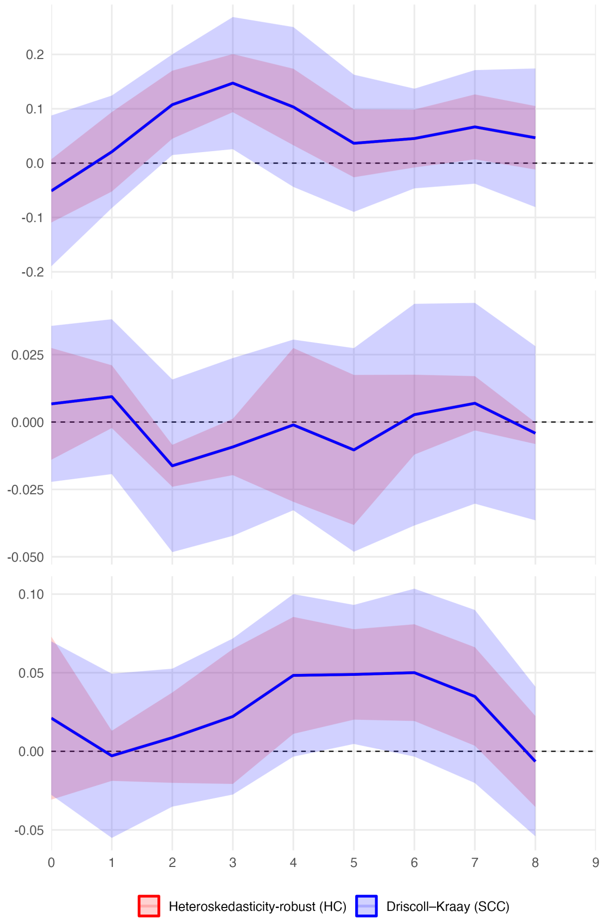

Figure 2: Impulse Responses to a GSCP Shock: Baseline Specification

Notes: The figure reports impulse responses to a standardized global supply-chain pressure (GSCP) shock. The three panels show the response associated with the main shock, the shock-trade openness interaction, and the shock-trade vulnerability interaction. Solid lines denote point estimates, while shaded areas denote 95 percent confidence intervals. HC refers to heteroskedasticity-consistent standard errors, and SCC refers to Driscoll-Kraay standard errors. The baseline specification includes lagged inflation and lagged GSCP shocks, as well as interactions of the shock with trade openness (TO) and trade vulnerability (GTVI), but does not include additional macroeconomic controls.

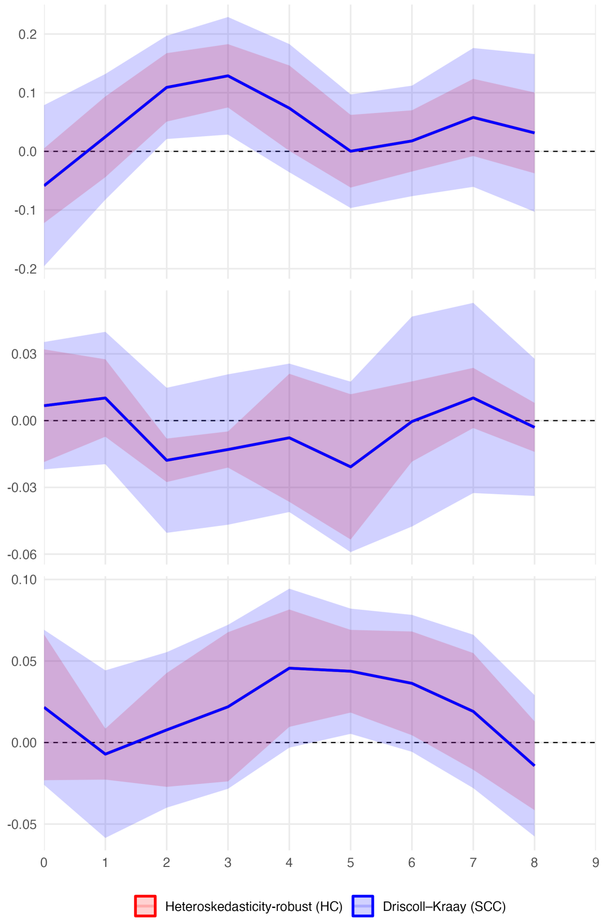

Figure 3: Impulse Responses to a GSCP Shock: Alternative Specification 1

Notes: The figure reports impulse responses to a standardized global supply-chain pressure (GSCP) shock. The three panels show the response associated with the main shock, the shock-trade openness interaction, and the shock-trade vulnerability interaction. Solid lines denote point estimates, while shaded areas denote 95 percent confidence intervals. HC refers to heteroskedasticity-consistent standard errors, and SCC refers to Driscoll-Kraay standard errors. Alternative specification 1 adds domestic macroeconomic controls, including inflation persistence, the output gap, real exchange-rate changes, and trade openness dynamics.

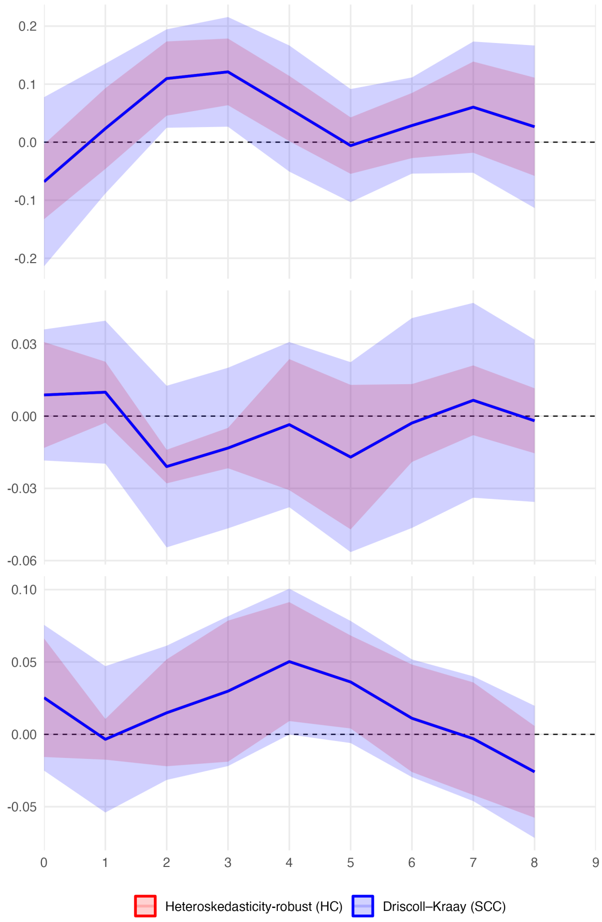

Figure 4: Impulse Responses to a GSCP Shock: Alternative Specification 2

Notes: The figure reports impulse responses to a standardized global supply-chain pressure (GSCP) shock. The three panels show the response associated with the main shock, the shock-trade openness interaction, and the shock-trade vulnerability interaction. Solid lines denote point estimates, while shaded areas denote 95 percent confidence intervals. HC refers to heteroskedasticity-consistent standard errors, and SCC refers to Driscoll-Kraay standard errors. Alternative specification 2 further adds global cost-push and policy controls, including commodity price inflation, oil price inflation, and changes in the monetary policy rate.

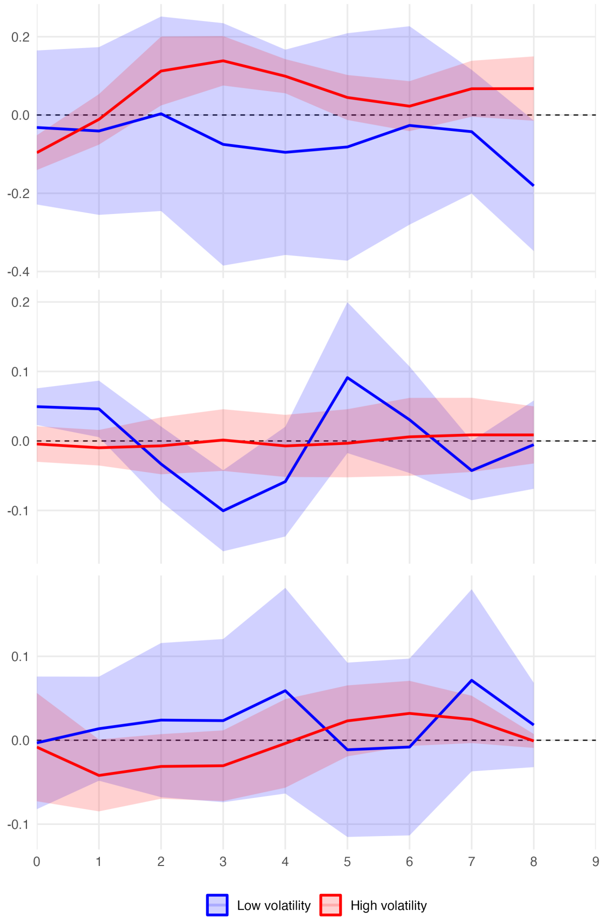

Figure 5: Impulse Responses to a GSCP Shock by Volatility Regime: Baseline Specification

Notes: The figure reports impulse responses to a standardized global supply-chain pressure (GSCP) shock under high- and low-volatility regimes. Regimes are defined using the rolling volatility of the estimated GSCPI innovation. The three panels show the response associated with the main shock, the shock-trade openness interaction, and the shock-trade vulnerability interaction. Solid lines denote point estimates, while shaded areas denote 95 percent confidence intervals computed using heteroskedasticity-consistent (HC) standard errors. The baseline specification includes lagged inflation and lagged GSCP shocks, but excludes additional macroeconomic controls. The regime split should be interpreted as comparing responses across more and less volatile GSCP environments, rather than as separately identifying shock-size effects from changes in transmission elasticity.

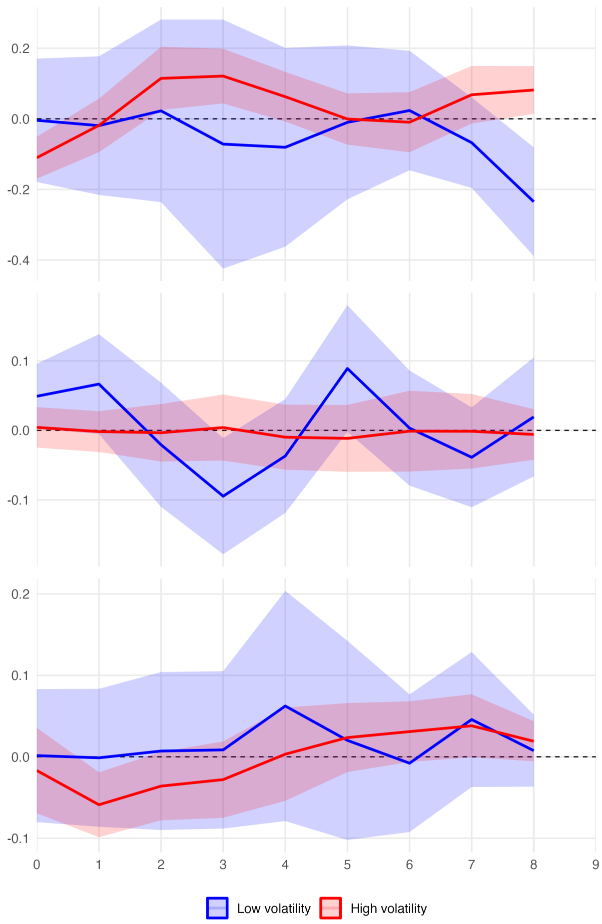

Figure 6: Impulse Responses to a GSCP Shock by Volatility Regime: Alternative Specification 1

Notes: The figure reports impulse responses to a standardized global supply-chain pressure (GSCP) shock under high- and low-volatility regimes. Regimes are defined using the rolling volatility of the estimated GSCPI innovation. The three panels show the response associated with the main shock, the shock-trade openness interaction, and the shock-trade vulnerability interaction. Solid lines denote point estimates, while shaded areas denote 95 percent confidence intervals computed using heteroskedasticity-consistent (HC) standard errors. Alternative specification 1 adds domestic macroeconomic controls, including inflation persistence, the output gap, real exchange-rate changes, and trade openness dynamics. The regime split should be interpreted as comparing responses across more and less volatile GSCP environments, rather than as separately identifying shock-size effects from changes in transmission elasticity.

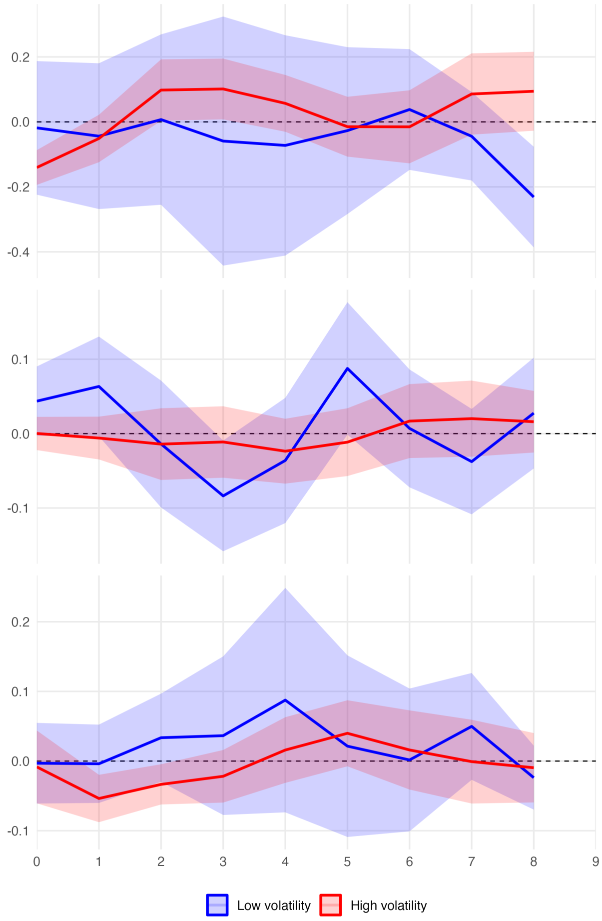

Figure 7: Impulse Responses to a GSCP Shock by Volatility Regime: Alternative Specification 2

Notes: The figure reports impulse responses to a standardized global supply-chain pressure (GSCP) shock under high- and low-volatility regimes. Regimes are defined using the rolling volatility of the estimated GSCPI innovation. The three panels show the response associated with the main shock, the shock-trade openness interaction, and the shock-trade vulnerability interaction. Solid lines denote point estimates, while shaded areas denote 95 percent confidence intervals computed using heteroskedasticity-consistent (HC) standard errors. Alternative specification 2 further adds global cost-push and policy controls, including commodity price inflation, oil price inflation, and changes in the monetary policy rate. The regime split should be interpreted as comparing responses across more and less volatile GSCP environments, rather than as separately identifying shock-size effects from changes in transmission elasticity.

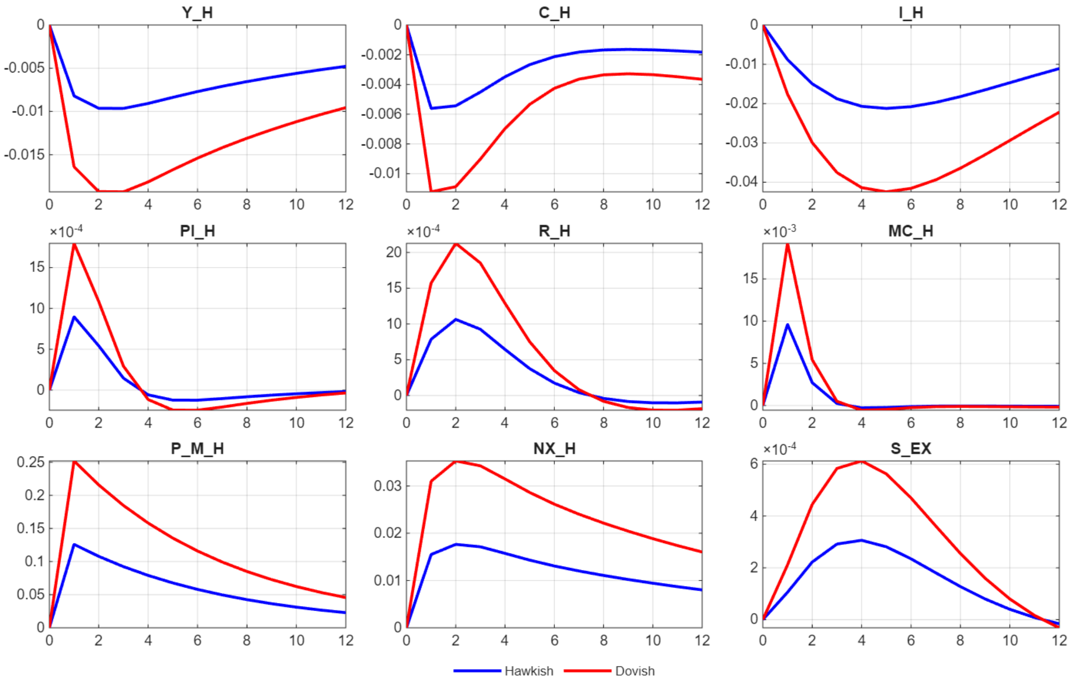

Figure 8: Impulse Responses to a GSCP Shock by Monetary Policy Regime

Notes: The figure reports impulse responses to a global supply-chain pressure (GSCP) shock under hawkish and dovish monetary policy regimes. Blue lines denote the hawkish policy regime, and red lines denote the dovish policy regime. The responses are computed under the high trade-vulnerability calibration and are expressed as deviations from the steady state. A dovish policy stance amplifies inflation, marginal-cost pressures, and real activity losses following global supply-chain disruptions, while a hawkish policy stance dampens inflationary propagation.

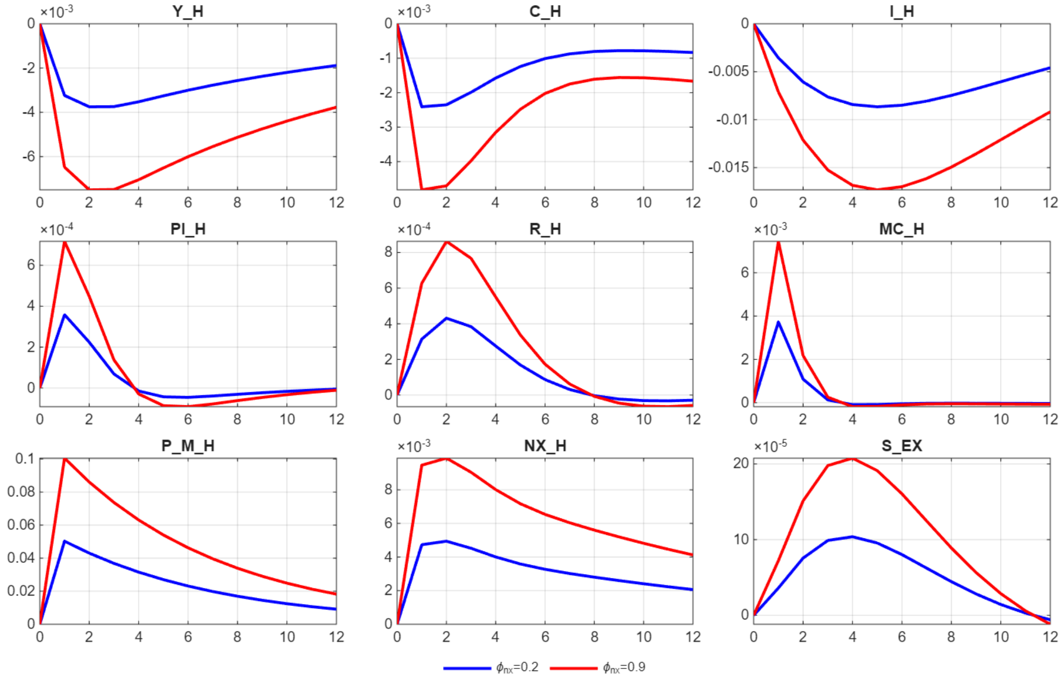

Figure 9: Impulse Responses to a GSCP Shock by Trade Vulnerability

Notes: The figure reports impulse responses to a global supply-chain pressure (GSCP) shock under alternative trade-vulnerability calibrations in the hawkish monetary policy regime. Blue lines correspond to the low-vulnerability calibration ($\phi_{nx} = 0.2$), and red lines correspond to the high-vulnerability calibration ($\phi_{nx} = 0.9$). Responses are expressed as deviations from the steady state. Higher trade vulnerability strengthens the pass-through of global supply disruptions into import prices and marginal costs, generating larger inflation responses and deeper contractions in output, consumption, and investment.

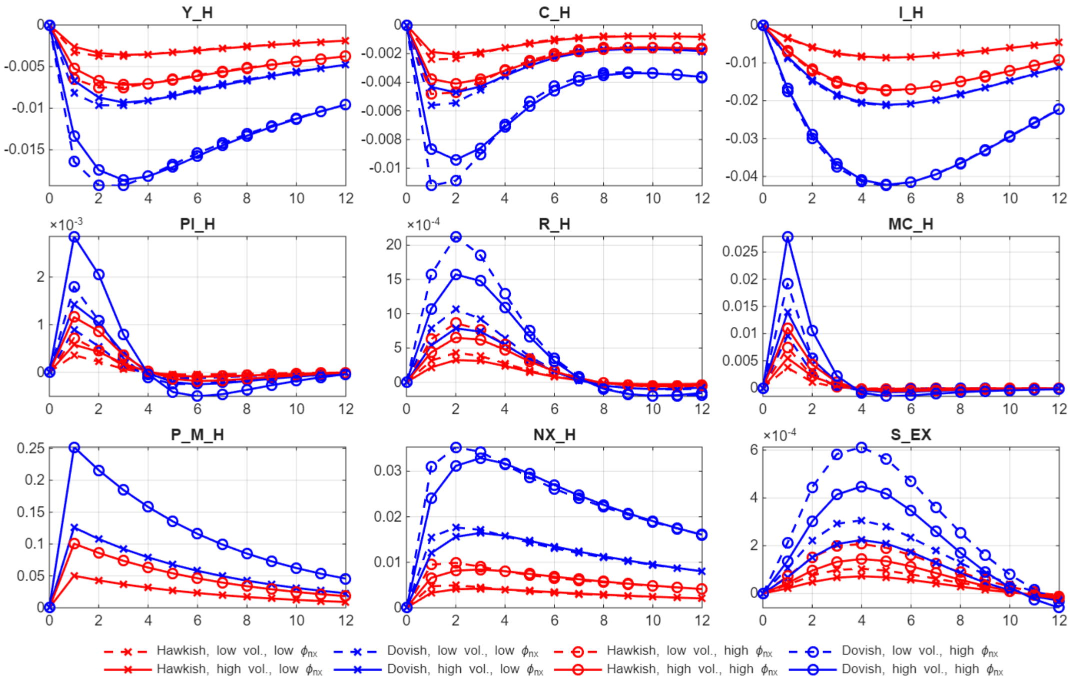

Figure 10: Impulse Responses to a GSCP Shock by Policy, Volatility, and Vulnerability Regimes

Notes: The figure reports impulse responses to a global supply-chain pressure (GSCP) shock under alternative combinations of monetary policy stance, GSCP shock volatility, and trade vulnerability. Red lines denote the hawkish policy regime, and blue lines denote the dovish policy regime. Dashed lines correspond to low GSCP volatility, and solid lines correspond to high GSCP volatility. Cross markers indicate the low-vulnerability calibration ($\phi_{nx} = 0.2$), and circle markers indicate the high-vulnerability calibration ($\phi_{nx} = 0.9$). Responses are expressed as deviations from the steady state. The largest macroeconomic fluctuations arise when high trade vulnerability coincides with high GSCP volatility and a dovish monetary policy stance.

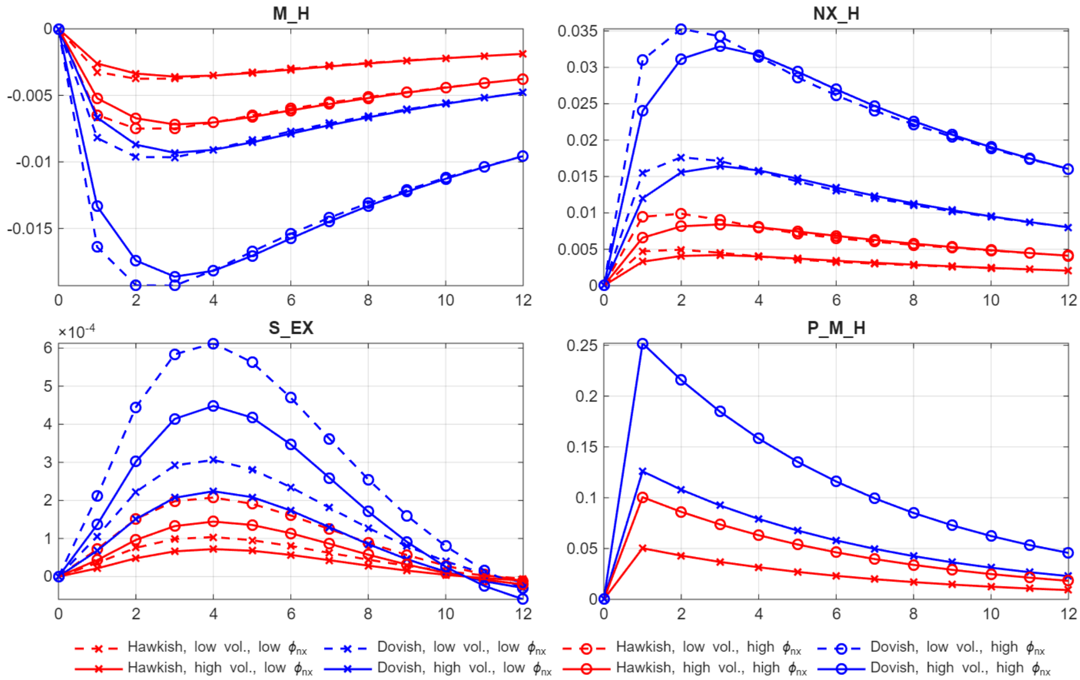

Figure 11: External Adjustment Responses to a GSCP Shock

Notes: The figure reports impulse responses of imports, net exports, the exchange rate, and import prices to a global supply-chain pressure (GSCP) shock under alternative monetary policy, volatility, and trade-vulnerability regimes. Red lines denote the hawkish policy regime, and blue lines denote the dovish policy regime. Dashed lines correspond to low GSCP volatility, and solid lines correspond to high GSCP volatility. Cross markers indicate the low-vulnerability calibration ($\phi_{nx} = 0.2$), and circle markers indicate the high-vulnerability calibration ($\phi_{nx} = 0.9$). Responses are expressed as deviations from the steady state. External adjustment is strongest under the dovish, high-vulnerability, high-volatility configuration, reflecting import compression, exchange-rate adjustment, and a temporary improvement in net exports.

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