Annexes: Selected Issues

1. Assessing the Impact of JPY Movements on the Japanese Economy [82]

This selected issue examines the impact of exchange rate fluctuations on both prices as well as real economic activities in Japan, providing empirical evidence to gauge the magnitude of these effects.[83] The findings reveal that while domestic consumption has shown resilience to real exchange rate shocks, the pass-through of nominal exchange rate changes to domestic prices has increased, and warrants close monitoring.

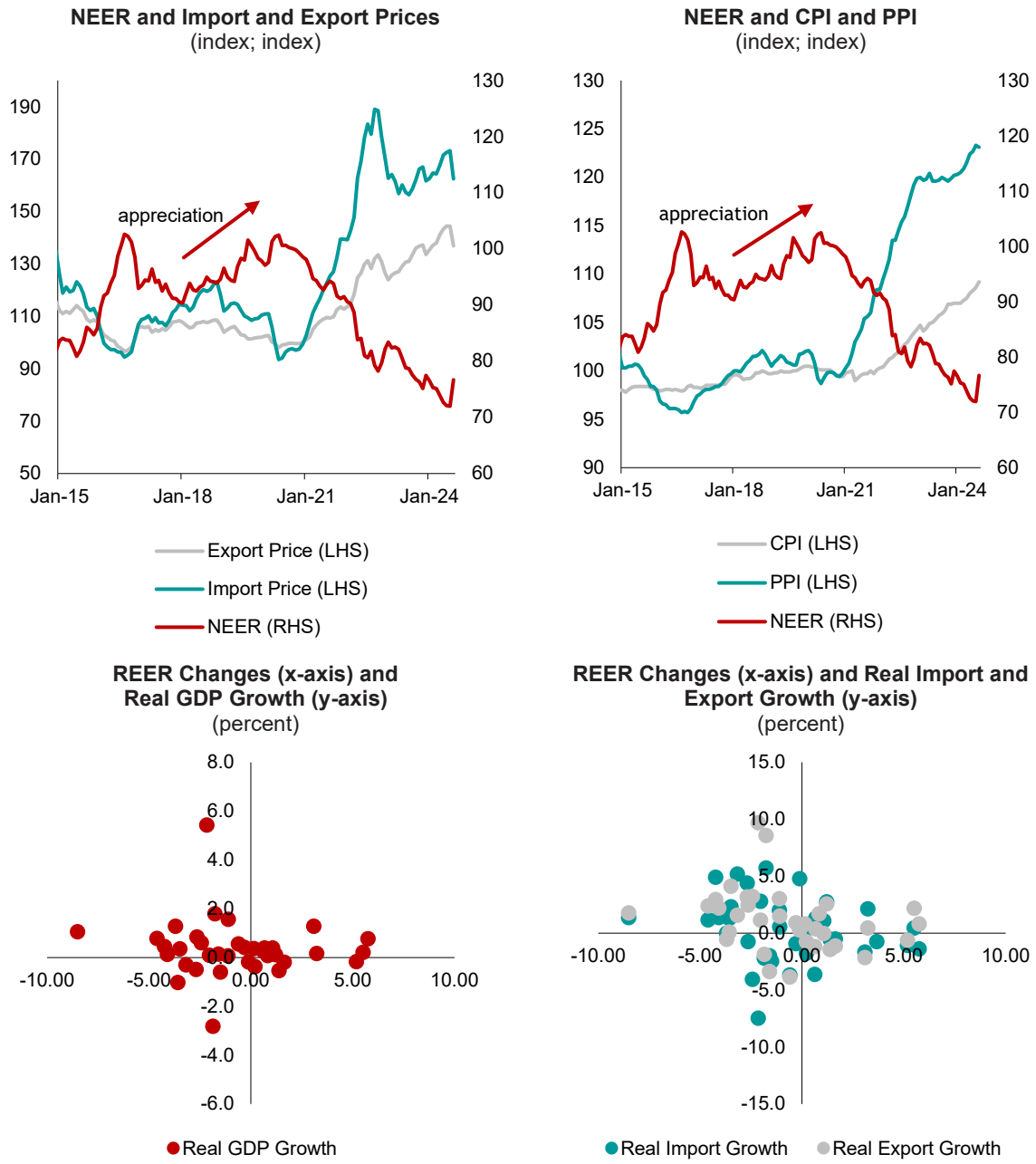
Background

1. **Japan's deep integration with the global economy highlights the importance of exchange rate dynamics in influencing prices, trade, and economic activities.** As a leading exporter of automobiles and advanced electronics, and an importer of essential commodities such as energy and manufacturing inputs, Japan's trade competitiveness and cost structures are highly sensitive to currency fluctuations. While nominal exchange rates affect prices and financial flows, real exchange rates play a crucial role in determining trade competitiveness and overall economic performance.[84]

2. **Over the past decade, the nominal effective exchange rate (NEER) generally exhibits an inverse relationship with price indices, while the impact of real effective exchange rate (REER) remains ambiguous.** The negative relationship between NEER and prices is particularly evident after the end of 2020 when both the Consumer Price Index (CPI) and Producer Price Index (PPI) rose sharply (Figure A1.1). A depreciation in the local currency, reflected by a lower NEER, is typically associated with higher local currency prices for imports and exports, as well as increases in producer and consumer prices. Although theory suggests that a depreciation in the real exchange rate can improve trade competitiveness, the actual effects of changes in the REER on economic activity and trade competitiveness are less certain, based on Figure A1.1; see, for example, Eichengreen (2007).

[82] Prepared by (Aruhan) Rui Shi, Associate Economist.
[83] This analysis does not address the relationship between exchange rate movements and financial accounts and cross-border portfolio flows for several reasons. One key reason is that cross-border flows, especially portfolio flows, are highly dynamic and influenced by various factors, including risk appetite, investor sentiment, and geopolitical uncertainty, making it challenging to isolate the effects specifically attributable to exchange rate changes compared to their impact on trade prices and volumes. Although beyond the scope of this note, financial flows are an important channel for future exploration, as they significantly influence investment decisions, corporate profitability, and broader economic activities.
[84] Selected Issue 1 of the 2022 Japan ACR outlined several channels demonstrating the impact of a weaker yen on the macroeconomy, including the domestic growth channel, terms of trade channel, imported inflation channel, and overseas investment channel.

Figure A1.1. Exchange Rate, Prices, and Economic Activity: 2015 - 2024



Source: Haver Analytics
Note: The NEER and REER are trade-weighted indices of nominal and real exchange rates respectively. For calculation methodology, please see BIS. An increase in NEER or REER indicates a strengthening of the currency. The CPI covers all expenditure categories.

Methodology

3. Vector Autoregression (VAR) models are employed to analyze nominal exchange rate pass-through (ERPT) and the effects of real exchange rate fluctuations on economic activity. The analysis of nominal exchange rate pass-through incorporates the CPI, PPI, import and export prices, and NEER. The VAR model (Equation 1) assumes that NEER immediately influences import and export prices, while their effects on CPI and PPI are seen with a time lag. To examine the impact of real exchange rate movements on the

economy, two separate VAR estimations are performed. The first assesses the impact of REER on GDP, incorporating variables such as real GDP in the U.S., Japan's real GDP, and REER. The second estimation evaluates REER's effects on trade, investment, and consumption, using variables including real imports, exports, investment, public and private consumption, and REER. The shocks within the VAR models are identified through Cholesky decomposition, which orthogonalizes residuals based on a specified recursive ordering of the variables.

$$Y_t = A_1 Y_{t-1} + \epsilon_t \quad (1)$$

- Y_t is the vector of endogenous variables at time t.
- A_1 is a coefficient matrix capturing the lagged relationships among variables.
- ϵ_t is the vector of error terms.

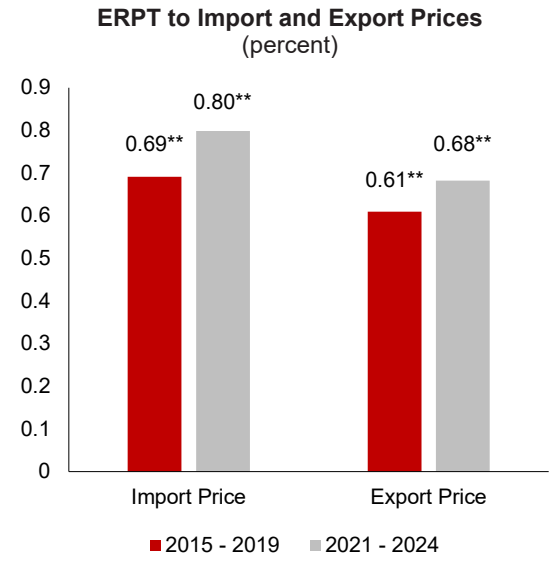
Findings

4. The degree of exchange rate pass-through (ERPT) to import prices is estimated to be higher than that to export prices. The estimates for ERPT to import prices range from 0.77 to 0.83, and for export prices from 0.67 to 0.68, using the overall data sample.[85] The findings confirm the widely observed pattern that exchange rate movements influence import prices more strongly than export prices.[86] While this remains an empirical puzzle, factors such as pricing-to-market strategies and invoicing currency partly explain the discrepancy. For instance, studies by Ito et al. (2016; 2018) highlight unique characteristics of Japan's export industry: Japanese exports to advanced economies are often invoiced in the importer's currency, and in trade with Asia, U.S. dollar invoicing is more prevalent than yen invoicing. These observations in combination of the dominant currency paradigm (Gopinath et al, 2016; 2020) can help partially explain the observed higher ERPT to import prices than export prices.

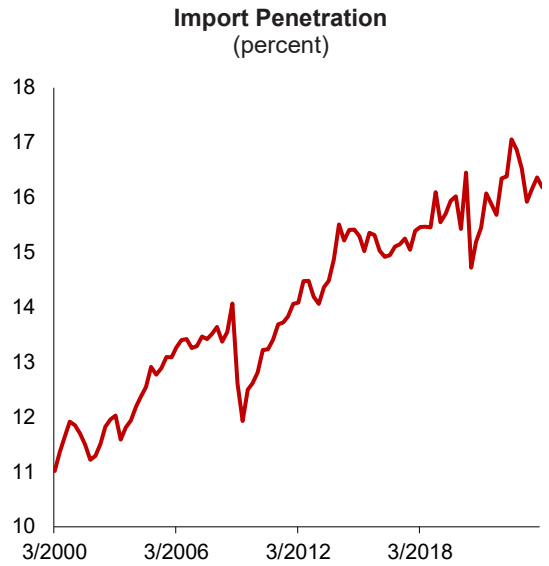
5. Meanwhile, the degree of exchange rate pass-through for both import and export prices has increased over time. This is evident from split-sample estimates comparing the periods 2015–2019 and 2021–2024.[87] The pass-through to import prices rose from an average of 0.69 to 0.80, while for export prices, it increased from 0.61 to 0.68 (Figure A1.2). The observed rise in pass-through may reflect shifts in inflation dynamics. From 2015 to 2021, CPI and PPI were relatively low and stable. However, both have risen significantly since then (Figure A1.1). Empirical evidence suggests that higher inflation and exchange rate volatility are weakly associated with a higher pass-through of exchange rates into import prices (Campa and Goldberg, 2002).[88] In addition, the increase in import penetration in Japan could help explain the higher pass-through observed recently from the exchange rate to import and export prices (Figure A1.2).

[85] The range of estimates reflects whether CPI or PPI is used in the model specification. The dataset covers monthly data from January 1995 to August 2024.
[86] Choudhri and Hakura (2012) reports ERPT estimates ranging from 0.90 to 0.98 for import prices and 0.55 to 0.56 for export prices, based on data from 1979 to 2010.
[87] In the split-sample analysis, 2020 is excluded to avoid sudden economic disruptions associated with the COVID-19 pandemic. The final data point for 2024 is as of August.
[88] Similarly, the macroeconomic conditions of export countries, including inflation, may impact exchange rate pass-through to export prices; however, this is not explicitly examined in this Selected Issue.

Figure A1.2. Nominal Exchange Rate Pass-Through and Import Penetration



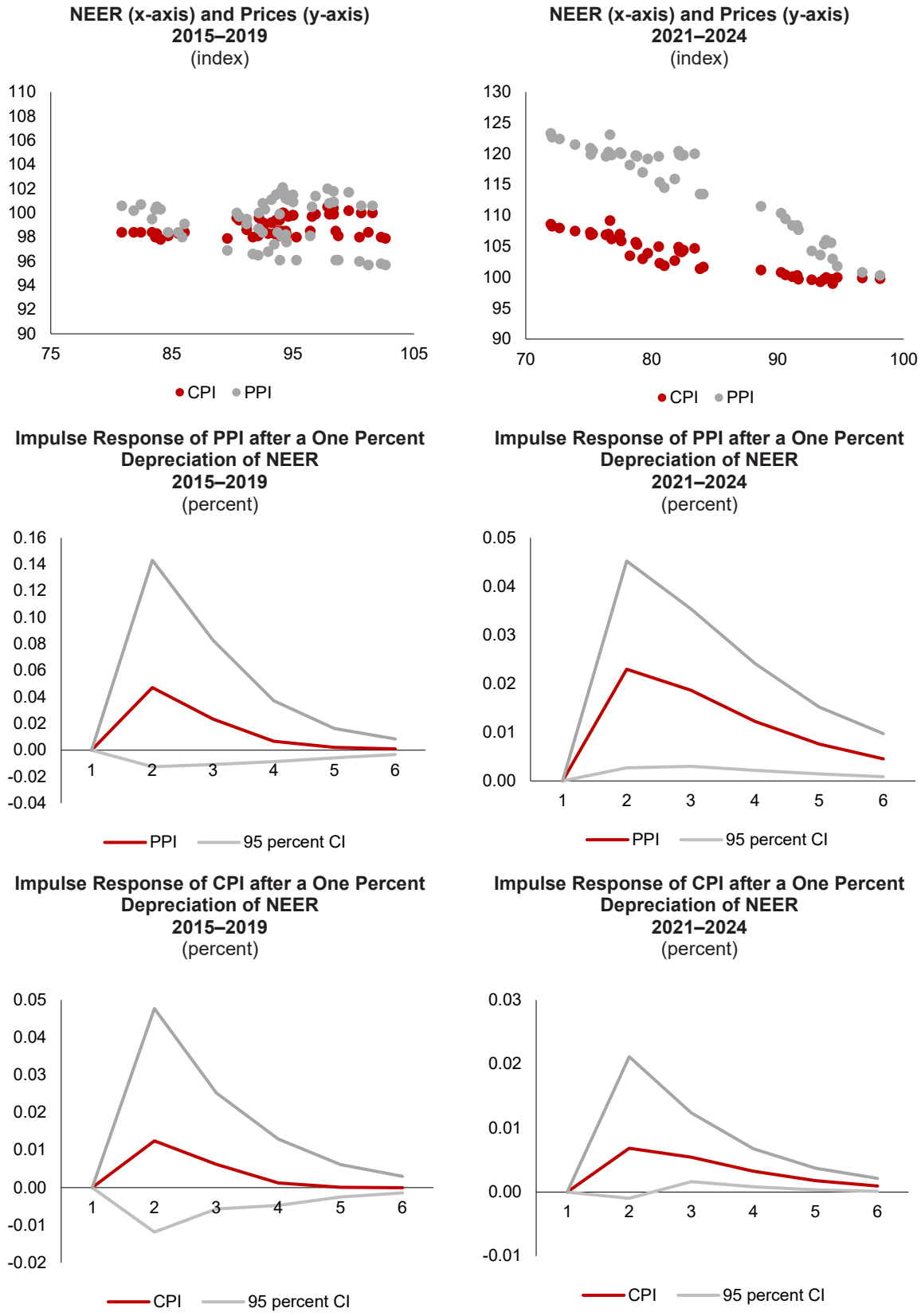
Source: Haver Analytics; AMRO staff estimations
Note: The estimation is done for a VAR model. Shocks in the model are identified using a Cholesky decomposition, which orthogonalizes residuals based on an assumed recursive ordering of variables. ** indicates statistical significance at the 5 percent level.



Source: CEIC; OECD; AMRO staff estimation
Note: Import penetration measures the degree to which imports contribute to meeting a country's domestic demand.

6. The exchange rate pass-through to PPI and CPI shifted from having a negligible impact during 2015–2019 to having a significant impact during 2021–2024. A comparison of scatter plots for NEER and prices across the two time periods reveals differing relationships (Figure A1.3). Between 2015 and 2019, the correlation between NEER and prices appears weak or inconsistent. However, from 2021 to 2024, a negative correlation is evident for both CPI and PPI, with PPI showing a stronger negative correlation than CPI. The VAR estimation reveals a pass-through elasticity of 0.023 for PPI and 0.005 for CPI between 2021 and 2024 (Figure A1.3). The rise in pass-through since 2021 could be attributed to evolving price dynamics in the economy, along with higher ERPT to import and export prices, as identified in previous estimations. While the pass-through has become significant in recent years, its magnitude remains modest. Several factors contribute to this limited pass-through. Discussions with private sector stakeholders reveal that firms, especially those operating in foreign markets, actively hedge against exchange rate risks, reducing the need for full cost pass-through. Additionally, domestic producers may absorb costs due to competitive pressures or use higher profit margins to cushion price adjustments.

Figure A1.3. Nominal Exchange Rate and CPI and PPI



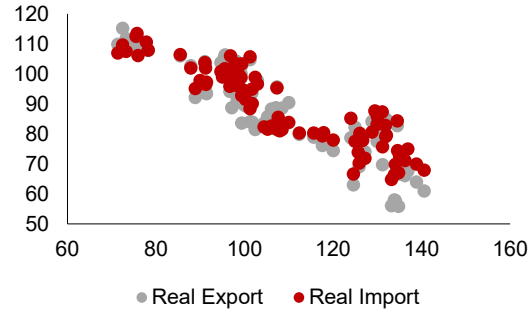
Source: Haver Analytics; AMRO staff estimations
Note: The figures display scatter plots and impulse response functions from the VAR model using NEER, with a 95% confidence interval (CI) applied. The final data point for 2024 is as of August.

7. Although the VAR estimations in this analysis assume symmetric exchange rate pass-through, evidence from the literature indicates the presence of asymmetry. For ERPT to export prices, Japanese exporters—particularly in general machinery and electric machinery sectors—tend to adopt a pricing-to-market strategy during yen appreciation in order to maintain price competitiveness in destination markets. In contrast, during yen depreciation, ERPT is higher because exporters benefit from substantial foreign exchange gains, allowing them to pass through more of the depreciation's effects to prices (Liu and Sato, 2024). In the case of ERPT to import prices, the asymmetry is reversed. ERPT is greater during yen appreciation than during depreciation. This phenomenon is driven by the behavior of foreign firms exporting to Japan. When the yen appreciates, the competitiveness of yen-denominated prices improves automatically, increasing export volumes and market share without necessitating price adjustments in the exporters' own currency. Consequently, a significant portion of the yen's appreciation is reflected in yen-denominated import prices. However, during yen depreciation, price competitiveness weakens, prompting foreign exporters to adopt pricing-to-market strategies. This approach minimizes excessive increases in yen-denominated prices, thereby limiting ERPT during depreciation (Yoshimi et al. 2024).

8. A temporary shock to the REER significantly affects real GDP, imports, exports, and investment, while having an insignificant impact on private and public consumption. Estimating a VAR model shows that a 1 percent depreciation in the REER is associated with an increase in real GDP growth by 0.11 percent, investment growth by 0.19 percent, import growth by 0.31 percent, and export growth by 0.45 percent (Figure A1.4).[89] These findings align with conventional wisdom: local currency depreciation improves trade balance and competitiveness, boosting investment and overall GDP growth (Habib, Mileva and Stracca, 2016; Rodrik, 2008; Brito, Magud and Sosa, 2018). Moreover, its negligible impact on domestic consumption suggests that the domestic economy is relatively resilient to real exchange rate changes. Alternatively, it may reflect limited price pass-through effects on the domestic sector.[90]

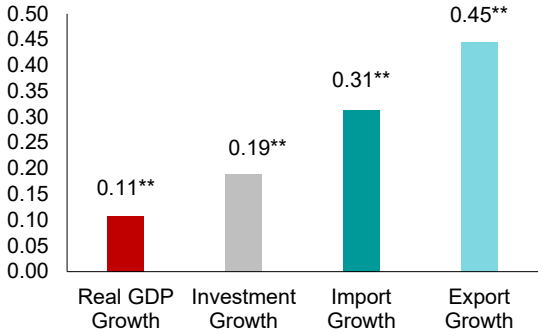
Figure A1.4. REER and Real Economic Activities

Scatter Plot of REER (x-axis) and Trade
(trillion yen)



Source: Haver Analytics; AMRO staff estimation
Note: The x-axis represents REER, while the y-axis displays real exports and imports.

The Impact of a 1 Percent Depreciation in REER on Real Economic Activities
(percent)

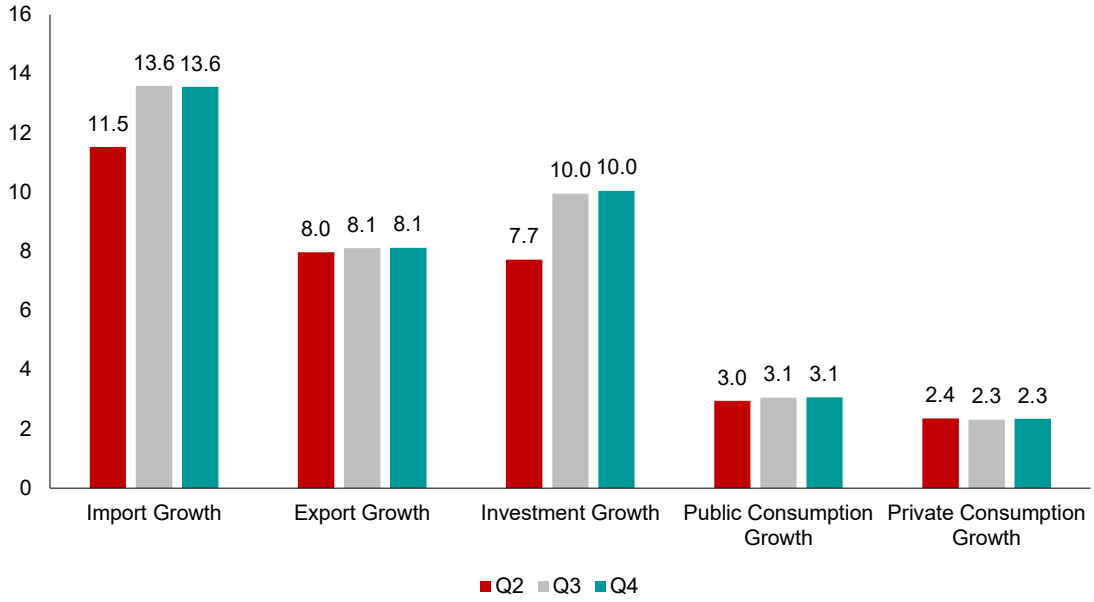


Source: Haver Analytics; AMRO staff estimation
Note: The results are derived from two VAR estimations. The first includes the real GDP growth rates of the U.S. and Japan, along with Japan's REER growth rate. The second includes the growth rates of real investment, real imports, real exports, real government consumption, real private consumption, and Japan's REER. The estimated impact on the growth rates of public and private consumption is insignificant and, therefore, not shown in the plot. ** indicates statistical significance at the 5% level.

[89] The dataset covers quarterly data from Q1 2003 to Q3 2024.
[90] A split-sample analysis of REER's impact on real economic activities was not conducted because the limited quarterly data span from 2021 to 2024 makes VAR estimation challenging.

9. Fluctuations in REER explain partially the volatility of import, export, and investment growth, while having a smaller effect on private and public consumption growth. Variance decomposition measures the relationship between volatility in REER and the other economic variables over time, ranging from six months to two years.[91] The results provide some indications whether real exchange rate fluctuation is a major contributor to macroeconomic volatility (Manalo, Perera and Rees, 2014). After an initial shock to REER, by the second quarter, it accounts for 11 percent of the volatility in import growth, 7.8 percent in export growth, and 7.5 percent in investment growth (Figure A1.5). In comparison, its impact on the volatility of private and public consumption growth is much smaller, at 2.5 percent and 3.1 percent respectively. When looking at the results beyond the second quarter, the increased contribution of REER volatility to import and investment growth may reflect lagged effects, such as adjustments in firms' cost structure or investment planning, which takes time to materialize and warrants further investigation based on firm-level data. Overall, the findings suggest that domestic consumption is relatively resilient to shocks from real exchange rate volatility.

Figure A1.5. Variance Decomposition: Impact of REER Volatility on Real Economic Variables
(Percent)



Source: Haver Analytics; AMRO staff estimation.
Note: The variance decomposition results from the VAR estimation show the proportion of a variable's volatility that is explained by fluctuations in other variables within the VAR system. This figure plots the percentage of a variable's volatility that is explained by fluctuations in REER.

Policy Implications

10. Domestic consumption has demonstrated resilience to real exchange rate shocks; however, the increasing pass-through of nominal exchange rate changes to domestic prices warrants close monitoring. Pass-through effects from nominal exchange rates to import and export prices have increased, with import prices experiencing greater pass through from exchange rate than export prices, likely due to differences in pricing behaviors and invoicing currencies between importers and exporters. Under the current positive inflation environment, the changing pricing behaviors across industries, real exchange rate trends, and

[91] The estimated impact remains constant after one year.

consumption patterns can have an impact on inflation dynamics and, therefore, an implication on monetary policy. Understanding the drivers of rising nominal exchange rate pass-through and the foundations of domestic consumption resilience is crucial in ensuring that exchange rate volatility does not lead to broader economic instability.

References

Brito, Steve, Nicolas E Magud, and Sebastian Sosa. 2018. “Real Exchange Rates, Economic Complexity, and Investment.” *IMF Working Papers*, No. 2018/107. May. Link.

Campa, José Manuel and Linda S. Goldberg. 2002. “Exchange Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon?” *NBER Working Paper*, No. 8934. May. Link.

Choudhri, Ehsan U., and Dalia S. Hakura. 2012. “The Exchange Rate Pass-Through to Import and Export Prices: The Role of Nominal Rigidities and Currency Choice,” *IMF Working Paper*, WP/12/226, September. Link.

Choi Jinho. 2022. “Assessing the Macroeconomic Impacts of a Weaker Yen in Japan.” *AMRO Annual Consultation Report on Japan.* Selected Issue 1. Link.

Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller. 2016. "Dominant Currency Paradigm." *NBER Working Paper*, No 22943. March. Link.

_____. 2020. "Dominant Currency Paradigm." *American Economic Review*, 110 (3): 677–719.

Habib, Maurizio Michael, Elitza Mileva, and Livio Stracca. 2016. “The real exchange rate and economic growth: revisiting the case using external instruments.” *ECB Working Paper Series*, No. 1921, June. Link.

Ito, Takatoshi, Satoshi Koibuchi, Kiyotaka Sato, and Junko Shimizu. 2016. “Choice of Invoice Currency in Japanese Trade: Industry and commodity level analysis.” *RIETI Discussion Paper Series*, 16-E-031, March. Link.

_____. 2018. “Choice of Invoice Currency in Japanese Trade: Industry and commodity level analysis.” In *Managing Currency Risk How Japanese Firms Choose Invoicing Currency*, 19 – 64. Edward Elgar Publishing.

Liu, Nan and Kiyotaka Sato. 2024. “Asymmetric Exchange Rate Pass-Through between Unexpected Yen Appreciation and Depreciation: The case for Japanese machinery exports.” *RIETI Discussion Paper Series*, No. 24-E-008, January. Link.

Manalo, Josef, Dilhan Perera and Daniel Rees. 2014. “Exchange Rate Movements and the Australian Economy.” *Reserve Bank of Australia Research Discussion Paper*, RDP 2024-11, November. Link.

Rodrik, Dani. 2008. “The Real Exchange Rate and Economic Growth.” *Brookings Papers on Economic Activity*. 2008(2): 365-412. Link.

Yoshimi, Taiyo, Uraku Yoshimoto, Takatoshi Ito, Kiyotaka Sato, Junko Shimizu and Yushi Yoshida Aoyagi. 2024. “Invoicing Currency and Exchange Rate Pass-Through in Japanese Imports: A Panel VAR Analysis.” *NBER Working Paper* 32910, September. Link.