

Depreciation and services trade: the evidence from Japan

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Abstract

Purpose – This study aims to examine the effects of currency depreciation and volatility on services trade balance and trade partner concentration and dynamics in Japan at a disaggregated level over the 2006M01 to 2023M09 period.

Design/methodology/approach – It applies linear and non-linear autoregressive distributed lag models and correlation analysis (including cross- and rank correlations) to identify strength, asymmetry and lags in the effects.

Findings – Except for a few cases, the evidence of both J- and S-curves was found weak and generally not asymmetric, as was the effect of currency volatility on trade balance. Trade partner concentration remained stable, and the dynamics of trade partner ranks were slow. The results are explained in terms of the specific response of services (as opposed to goods) trade to depreciation, the nature of competitive processes and corporate reorganisations in Japan and the macroeconomic policy of the recent 2 decades.

Originality/value – The study is one of a kind that examines J- and S-curve effects in services, incorporates volatility and considers trade partner composition effects.

Keywords J-curve, Services, Volatility, Trade partner, Japan

Paper type Research article

1. Introduction

Japan, due to its deficiency in natural resources and a large productive capacity, relies on foreign trade as an engine of economic development (Davis, 2021). Over the years, it amassed a large trade surplus that, however, has been dwindling over the years, turning zero in recent years and becoming negative at 3.8% of gross domestic product (GDP) in 2022 (Santander Trade, 2024). The potential role of services to reverse the trend is indispensable, but the services trade balance has been in chronic deficit recently, with services imports exceeding exports and large outbound payments for digital services and royalties prominent (Sasaki, 2024). Depreciation of the yen as a way to correct trade imbalances is conventionally believed to benefit the Japanese economy, with a weaker yen decreasing the prices of exported goods in the long run and increasing sales and profits of exporting firms (Ito, 2023). On the other hand, the depreciation does not address other aspects of the competitiveness of Japanese products and services in international markets or the strategies of Japanese corporations, e.g. overseas subsidiaries or affiliates. The improvement of trade balance following depreciation may thus be limited. The volatility of the Japanese yen has been the highest among major currencies, resulting from significantly lower interest rates in Japan and the carry-trade phenomenon. This created a currency competition environment, with potential negative consequences of trade

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conflicts, loss of international market share, shifting of exchange rate risks to importers (imported inflation) and the potential to hurt trade balance (Zeyang, 2023).

Overall, the effects of the fluctuations of the Japanese yen on Japan's trade balance and trade partner structure require empirical testing, particularly given the likely differential influence of the fluctuations on different industries and the uncertainty about how these mechanisms operate in the service trade.

This paper examines the effect of changes in the level and volatility of the Japanese yen on Japan's disaggregated services trade balance and services trade partner composition (concentration and rank dynamics). It looks at both short- and long-run effects on the trade balance (J- and S-curve dynamics), considers asymmetric reactions in the balance to currency appreciation versus depreciation, incorporates exchange rate volatility in the model and traces changes in the trade partner ranks and relative power. The study considers six service sectors and applies the linear autoregressive distributed lag (ARDL) and non-linear autoregressive distributed lag (NARDL) models and correlation measures (Pearson, rank and cross-correlation) to the monthly series stretching from 2006M01 to 2023M09. The paper specifically poses three related questions:

- (1) Does depreciation lead to a long-run improvement in the services trade balance?
- (2) Do differences across service categories and asymmetries exist following depreciation?
- (3) Does currency volatility play any role in service trade balance dynamics?
- (4) Do currency fluctuations affect the trade partner composition of Japan's services trade (rank of partners and concentration ratio)?

The novelty of this paper is the consideration of these issues in the context of Japan's services trade. Such analysis is essential, given the significance of Japan's aggregate services trade [1], differential dynamics of the services sub-sectors, the likely different sensitivity of sectors or industries to exchange rate fluctuations [2] and conceptual differences between goods and services trade, including when it comes to the above-mentioned arguments specific to Japan [3].

2. Literature review

The evolution of the trade balance along a J-shaped curve and the related Marshall–Lerner condition imply deterioration of net exports and trade balance in the short run after depreciation of domestic currency, followed by the formation of the trade surplus in the long run. The variable shape of the trade balance is attributed to changes in the value of price elasticities of exports and imports over time and the temporal discrepancy between the price and volume effects of currency depreciation. With the domestic price of an imported good being a product of the price of the good in the foreign market and the exchange rate, and given inelastic imports and exports in the short run, the price effect of depreciation makes imports more expensive and exports cheaper without decreasing the import volumes (increasing export volumes), thereby reducing the value of net exports and trade balance (downward segment of the J-curve). In the long run, the balance between price and volume effects will reverse due to greater values of price elasticities of imports and exports, resulting in a decrease in imports and an increase in export volumes and trade balance (upward segment of the curve).

The configuration of elasticities plays a critical role in the reversion of the trade balance from deficit to surplus in the long run. Assuming the trade balance is given as $N_x = X - Qe$, with X and Q being exports and imports and e being an exchange rate, the sum of export and import elasticities greater than one will ensure the presence of the J-curve and improvement in the balance as follows:

$$\frac{\partial N_x}{\partial e} \frac{e}{X} = \eta_{Xe} - \eta_{Qe} - 1 \quad (1)$$

$$\eta_{Xe} + |\eta_{Qe}| > 1 \quad (2)$$

The presence of the J-curve requires various assumptions about the behaviour of the trading agents and the structural composition of trade. The obligations to honour old contractual obligations that were agreed upon based on the exchange rates prior to depreciation will prevent the change in export and import quantum in the short run (Leonard and Stockman, 2001), while the persistence of purchasing habits will bring slack in the substitution between imported and domestic goods (Bahmani-Oskooee and Ratha, 2004). The required higher elasticity of exports and imports in the long run, in turn, is not uniform across the goods and services traded, with certain goods or industries having higher long-run elasticity than the others (Doroodian *et al.*, 1999).

The J-curve studies in Japan's context mostly concerned aggregate trade. Anju and Uma (1999) and Hsing (2005) confirmed the J-curve effect for the flexible exchange rate regime period and the aggregate trade, respectively. Backus (1993) likewise established the J-curve in Japan using the vector autoregression model. On the other hand, Lal and Lowinger (2002) did not find support for this effect in Japan, in contrast to other East Asian economies. Kubo (2023) identified the J-curve only in selected industries and regions (automotive sector in Kansai). Bahmani-Oskooee *et al.* (2017), in Japan's bilateral trade study, found many instances of the J-curve, but only if a non-linear model is used. The mixed findings suggest further research on the topic.

Studies of the J-curve in the services trade have been scant with mixed findings. Cheng (2021), in the ARDL study of the financial and insurance trade of the US, attributed the absence of the curve to the stringent assumption of the symmetric effects of currency devaluations. Prakash and Maiti (2016), in their study of Fijian trade, confirmed limited sensitivity of the services trade balance to exchange rate changes, a finding confirmed by Trofimov (2023) across the UK services trade categories. The complex reactions with initial improvement, worsening and further improvement of the balance were identified by Yazici (2010) in the study of Turkish services trade. Service-specific responses with limited (or conversely strong) sensitivity of balance to exchange rate were demonstrated by Cheng (2020) in the study of US trade in services. In a bilateral trade setting, Bahmani-Oskooee and Karamelikli (2023) also confirmed mixed effects, with asymmetric, symmetric and asymmetric inverse J-curves in the financial and insurance services trade of the US with its partners. On the other hand, Wijeweera and Dollery (2013), based on error-correction methodology, provided evidence of services trade in Australia. Trofimov (2024) confirmed the J-curve effect in Canada (on both bilateral and aggregate basis), while Pattichis (2012) provided some evidence of the effect in the study of US-UK trade.

An alternative approach to testing the short-run effects of depreciation relies on the S-curve effect and examination of the cross-correlation functions (Backus *et al.*, 1994). The S-curve shape in trade balance is a reflection of domestic productivity and technology shocks and a counter-cyclical property of net exports. Consumption is less procyclical than output, due to consumption smoothening, while investment is more procyclical. Given that net exports is the difference between output and the sum of consumption and investment, it is thus counter-cyclical and negatively related to output [4]. Thus, a one-off increase in domestic output brings a greater increase in investment and an initial deterioration of trade balance. Over time, the investment boom dissipates and the trade deficit is superseded by a trade surplus. The positive effects of depreciation on trade balance are supported if the correlation coefficient between the current exchange rate and future (past) trade balance is positive (negative). An additional insight that may be made from the S-curve is the possible presence of the Harberger-Larsen-Metzler (HLM) effect, whereby adverse shock to relative prices of exports and imports causes

deterioration in savings and current account. The HLM effect is supported if the contemporaneous correlation between the exchange rate and trade balance (both at lag zero) is negative. Lastly, the consideration of the S-curve allows tracing the exchange rate pass-through, with the S-curve supporting complete pass-through and the absence of the curve indicating the incomplete process (e.g. due to markup adjustments after the depreciation, [Gagnon and Knetter, 1995](#)). The S-curve was tested on a smaller number of occasions, both at the aggregate, product/industry-specific or trade partner level, e.g. [Senhadji \(1998\)](#) confirmed the presence of the S-curve for 11 Organisation for Economic Co-operation and Development (OECD) countries' aggregate trade; [Bahmani-Oskooee and Ratha \(2009\)](#) established the S-curve in the US-Canada bilateral trade at the disaggregate level and [Bahmani-Oskooee and Xi \(2015\)](#) found more limited evidence of the curve in the US-Brazil disaggregated trade. For Japan, the strong evidence of the phenomenon at the disaggregated product level was provided by [Bahmani-Oskooee and Ratha \(2007\)](#). A useful survey of S-curve studies was provided by [Bahmani-Oskooee and Hegerty \(2010\)](#).

The second pillar of this study is the examination of the effects of real exchange rate volatility on the trade balance dynamics. The effects of exchange rate on the trade flows are not limited to the changes in the level of exchange rate (which were the subject in the early theorising epitomised in the Marshall–Lerner condition and the J- and S-curve effects) but also include the changes in the exchange rate variance (volatility). There is disagreement regarding the sign of the exchange rate volatility effects on trade. On one hand, volatility is known to distort the efficient allocation of resources and to complicate macroeconomic policy ([Gagnon, 1993](#)). At the firm level, greater volatility increases the transaction costs of conversion between the currencies, which for risk-averse firms works as an incentive to reduce the volume of trade ([Hooper and Kohlhagen, 1978](#)). Thus, the likely effect of the higher volatility on the trade balance is negative. On the other hand, the degree of risk aversion of the firms is variable, and the actual response to higher volatility may involve two opposing effects: substitution, whereby volatility reduces trade flows, and income, whereby firms increase trade flows to offset a decline in total expected utility ([De Grauwe, 1988](#)). Currency hedging creates additional complications: when incorporated in higher prices as a risk premium, it may have a negative effect on production, consumption and trade. The specific nature of the industry exposed to volatility matters too: price volatility, trade barriers, homogeneity of goods and the size and reach of firms ([Huchet-Bourdon and Korinek, 2011](#)). Overall, the effect of volatility on trade balance is indeterminate.

Lastly, we examined the effect of depreciation on product and trade partner composition. Concentration and diversification of trade are typically seen as a product of overall development level that fosters diversification, financial integration that enhances access to larger markets and technological change that improves product mix alongside a greater number of partners, gravity and geographic factors such as economic size, trade distance and cost variables and sector-specific factors ([Bahar and Santos, 2018](#)). The macroeconomic and external competitiveness factors (including the level of relative prices, tariffs and exchange rates) may have an ambiguous effect on trade partner composition, on one hand disrupting existing trade channels, and on the other hand, driving countries to seek new trade opportunities. [Krugman \(1987\)](#) argues that currency depreciation may have a permanent effect on trade patterns and concentration via learning by doing: the new export variety or new trade partner may become dominant in the market, while sunk costs associated with developing new production plants make producers unwilling to revert to the earlier production or trade patterns. [Rodrik \(2009\)](#) views the relationship as positive, with exchange rate shock potentially reversing the earlier sub-optimal production or trade patterns. On the other hand, changes in the level and volatility of the exchange rate may have a permanent negative effect on manufacturing trade shares or trade shares of small producers and/or industries ([Bergin and Corsetti, 2013](#)). The majority of studies considered the exchange rate and macroeconomic effects on export concentration along product lines. The study of trade partner concentration determinants by [Afonso et al. \(2024\)](#) stands as an exception, albeit not containing formal

modelling of depreciation effects. It remains to be seen whether currency depreciation is potent enough to change the patterns. Babones *et al.* (2011) note that despite macroeconomic perturbations of recent decades and the rise of China in international trade, the trade partner structure of international trade remained remarkably stable. Arguably depreciation may work stronger through goods (versus services) trade and may need to be substantial (in terms of magnitude, length or recurrence, e.g. major currency crisis) to have an effect.

This study attempts to complement the existing literature (given the limited analysis of currency volatility and level changes on services trade balance and trade partner composition) by conducting a disaggregated analysis of the services trade in a large and open economy like Japan.

3. Method

3.1 Research design/model

Following Nusair (2017) and other similar studies, the long-run model is given as

$$\Delta \ln TB_t^i = a + b \ln Y_t^{JP} + c \ln Y_t^W + d \ln REX_t + COVID_t + \varepsilon_t \quad (3)$$

Where TB_t^i is Japan's trade balance in service i (defined as the ratio of the value of imports M to the value of exports X), Y_t^{JP} is the index of industrial production in Japan, Y_t^W is the index of industrial production in OECD countries and REX_t is real effective exchange rate (REER) of the Japanese yen, constructed such that a decline represents a depreciation in the yen. To ensure stability of the model and to account for a major structural break during the study period, the dummy variable $COVID_t$ was defined, taking the value of one during the COVID-19 pandemic and zero otherwise. All variables except for the dummy are represented in natural logarithms.

3.2 Data and variables

The study uses monthly data stretching from 2006M01–2023M09. The exports and imports (and hence, the trade balance) data were obtained from the World Trade Organisation Statistics database. The levels of economic activity and REER were sourced from the OECD database and Federal Reserve Economic Data, respectively. The trade partners' data is obtained from the WTO-OECD Balanced Trade in Services Dataset covering major trade sectors and spanning 2005–2021. Trade balance was seasonally adjusted to ensure monotonous adjustment to equilibrium in the ARDL and NARDL models [5].

3.3 Analytical procedures

This study tests the J-curve effect hypothesis on ARDL and NARDL models that have several advantages (applicability to variables of mixed integration order [6], flexible lag structures of dependent and independent variables to trace the dynamic response to shocks, separation of long- and short-run dynamics that is important for the J-curve analysis, single equation setting without need to order the variables).

The complete forms of ARDL and NARDL are given, respectively, as

$$\begin{aligned} \Delta \ln TB_t^i = & a' + \sum_{j=1}^n b'_j \Delta \ln TB_{t-j}^i + \sum_{j=0}^n c'_j \Delta \ln Y_{t-j}^{JP} + \sum_{j=0}^n d'_j \Delta \ln Y_{t-j}^W + \sum_{j=0}^n e'_j REX_{t-j} + \rho_0 \ln TB_{t-1}^i \\ & + \rho_1 \ln Y_{t-1}^{JP} + \rho_2 \ln Y_{t-1}^W + \rho_3 \ln REX_{t-1} + \varphi COVID_t + \varepsilon_t \end{aligned} \quad (4)$$

and

$$\begin{aligned} \Delta \ln TB_t^i = & a' + \sum_{j=1}^{n1} b_j'' \Delta \ln TB_{t-j}^i + \sum_{j=0}^{n2} c_j'' \Delta \ln Y_{t-j}^{JP} + \sum_{j=0}^{n3} d_j'' \Delta \ln Y_{t-j}^W \\ & + \sum_{j=0}^{n4} e_j^+ \Delta POS_{t-j} + \sum_{j=0}^{n5} e_j^- \Delta NEG_{t-j} + \theta_0 \ln TB_{t-1}^i + \theta_1 \ln Y_{t-1}^{JP} + \theta_2 \ln Y_{t-1}^W \\ & + \theta_3 \ln POS_{t-1} + \theta_4 \ln NEG_{t-1} + \varphi COVID_t + \varepsilon_t \end{aligned}$$

The short-run effects are represented by c' , d' and e' in ARDL and c'' , d'' , e^+ and e^- in NARDL models. The long-run effects are obtained by estimates of ρ_1 , ρ_2 and ρ_3 normalised on $-\rho_0$ in ARDL and by estimates of θ_1 to θ_4 normalised on $-\theta_0$ in NARDL. In the NARDL model, POS is given as the partial sum of REER representing only the positive changes in the REER of the Japanese yen (i.e. yen appreciation). $COVID$ dummy, given its transitory effect on the economy, was included in the short-run component of the model. Similarly, NEG is the partial sum of REER standing for the negative changes in the REER of the Japanese yen (yen depreciation). Cointegration between the variables in the long run is verified via the bounds F-test checking the joint significance of the lagged variables and the t -test checking the significance of $\hat{\rho}_0$ in ARDL or $\hat{\theta}_0$ in NARDL. For the NARDL model, we distinguish the short-run asymmetry in size, associated with the different values of e^+ and e^- , $e_j^+ \neq e_j^-$ and $\sum e_j^+ \neq \sum e_j^-$, verified by Wald-S test and long-run asymmetry represented by the rejection by the Wald-L test of the equality $\theta_3/-\theta_0 = \theta_4/-\theta_0$. The J-curve is present when REX is negative and positive, respectively, in the short and long runs. Y^W is hypothesised to be positive, due to the positive relationship between Japan's exports and world income. Y^{JP} is assumed to be negative, due to the negative relationship between Japan's imports and Japan's income.

For S-curve analysis, the correlation was calculated between the current level of real exchange rate (RE) and the past and future values of the trade balance (TB).

$$CCF = \frac{\sum (RE_t - \overline{RE}) (TB_{t+k} - \overline{TB})}{\sqrt{\sum (RE_t - \overline{RE})^2 \sum (TB_{t+k} - \overline{TB})^2}} \quad (6)$$

with $k = -n, \dots, 0, \dots, +n$.

For the analysis of volatility effects, two measures were used: the first based on the standard deviation of the REER; the second based on the conditional variance of the exchange rate extracted from the generalized autoregressive conditional heteroskedasticity-in-mean (GARCH-M) model. In the former case, the moving standard deviation with a 12-month window is calculated. In the latter case, the volatility is obtained from the regression of the monthly exchange rate returns on constant and own lag, with variance in the GARCH-M process estimated as:

$$\sigma_t^2 = \varpi + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 + \sum_{i=1}^p \alpha_i \varepsilon_{t-ij}^2 \quad (7)$$

The simplest specification of GARCH-M process was adopted with $p = 1$ and $q = 1$. Arguably, the conditional measure of volatility is superior in that it accounts for the relationship between information set and volatility and allows for volatility clustering (Singh, 2004). The volatility measures were included as an additional regressor in the equation for the J-curve estimation.

For the analysis of effects on trade partners, the trade partner shares were calculated for the top 20 exporters and importers of services from/to Japan. The top five trade partner concentration ratio was then calculated as the sum of shares. To trace the dynamics in the ranks of the top 20 trade partners, the Kendall's index of rank concordance was estimated as

$$RC_a = \frac{Var(AR(Y)_{it} + AR(Y)_{i0})}{Var(2 * AR(Y)_{i0})} \quad (8)$$

where $AR(Y)_{it}$ and $AR(Y)_{i0}$ are ranks in initial and subsequent periods, with $RC_a \in (0, 1)$.

The maximum change in ranks (mobility) is indicated when the index is at the minimum (zero). Lastly, to examine the effects of exchange rate on trade partner concentration and rank dynamics, the contemporaneous and cross-correlations (with a maximum of two annual lags and leads) between exchange rate and concentration ratio or concordance index were estimated.

4. Results

As a benchmark, we estimated the linear ARDL model. The suitability of the ARDL model was thus confirmed for every sector, with none of the variables being integrated of order two, I (2). Given the monthly frequency of the data, the maximum number of lags was set at twelve, with the optimal lag selected based on Akaike Information Criterion.

The short-run coefficient was negative in all categories but significant only in construction, financial services and transport (Table 1). The long-run REX coefficient was positive in financial services, charges for the use of intellectual property and transport (significant only in the latter two categories). The long-run coefficient was negative in construction, other business services and telecommunications. The inverse J-curve (corresponding to improvement of the trade balance in the short run and deterioration in the long run) was thus observed in the latter category, given the significance of the REX coefficient.

The effect of world income was positive and significant in the financial services, charges for the use of intellectual property and transport categories (as expected, given exports are a function of world income) and negative and significant in the case of telecommunications. The effect of Japan's domestic income was negative and significant, as expected, in charges for the

Table 1. Estimates of the linear model

Category	Short run estimates		Long run estimates			
	REX	Significant lags	Yw	YJP	REX	COVID
Construction	-2.290** (1.116)	2	-0.160 (1.166)	-0.557 (0.961)	-0.175 (0.399)	-0.252** (0.091)
Financial services	-2.078** (0.875)	2, 5, 6, 9	2.429** (1.009)	0.057 (0.857)	0.278 (0.379)	0.095 (0.079)
Charges for the use of intellectual property	-0.318 (0.726)	Nil	3.710** (0.950)	-3.836** (0.801)	0.751** (0.306)	-0.041 (0.067)
Other business services	-0.218 (0.468)	Nil	-0.416 (0.471)	0.066 (0.397)	-0.413** (0.162)	-0.036 (0.037)
Telecommunications	-0.310 (0.833)	Nil	-5.772** (1.860)	5.534** (1.469)	-0.464 (0.579)	-0.007 (0.125)
Transport	-0.822** (0.229)	10	1.888** (0.473)	0.057 (0.574)	0.443** (0.185)	0.113** (0.046)

Note(s): (*) and (**) indicate significance at 10% and 5% levels. REX: Real exchange rate; YJP: GDP of Japan
Source(s): Authors' own work

use of intellectual property, but positive in telecommunications. The negative effect of the rest of the world's GDP on Japan's services trade balance in selected categories can be attributed to the weakness (relative to peer economies) and loss of competitiveness of the services documented in various studies, resulting in the sluggish export growth despite solid GDP growth in developing markets and Asia (Hogen *et al.*, 2024). The manufacturing sector malaise was not accompanied by the growth of and exports of knowledge-intensive services to the extent that it happened in other G7 economies (Makita, 2022). The positive effects of domestic GDP on services trade balance can be attributed to substantial (relative to trade in manufactured goods) trade barriers in the services sector, particularly in regard to foreign entry (e.g. equity restrictions on business ownership and non-transparent regulations), which stymies import growth in services (Lee, 2006).

Overall, the linear ARDL model gives little evidence to support the J-curve in trade balance. The result may be due to the underlying data structure (frequency and time span) or alternatively to the linearity assumption (Nusair, 2017). The effects of COVID-19 were of opposite direction in construction and transportation: the literature identified differential effects of COVID-19 on individual sectors or industries [7]. In this study, the positive effect on transportation trade could be explained by the closure of the borders and the reduction of the outbound travel (which over the years grew more prominent in Japan), while the negative effect on construction was explained by the reduction of economic activity during the pandemic.

All models in question were diagnostically sound (Table 2). The null hypothesis of no cointegration of the bounds test was rejected at the 5% critical level for all sectors except telecommunications, while the *t*-test' null hypothesis was rejected at the 5% critical level for all sectors except telecommunications and transport. The error-correction term was significant in every sector, with all sectors characterised by a high speed of correction to equilibrium following the shock to the system (50–70% of errors corrected in a single period) and monotonous adjustment to equilibrium, given that the error-correction coefficient was within the (0; -1) range. The models were stable and had no serial correlation or functional misspecification.

In the NARDL model (Table 3), the negative long-run coefficient NEG_{t-i} that represents improvement of the trade balance following depreciation was observed only in other business services category. The coefficient was positive in telecommunications and transport, indicating the deterioration of the balance even in the long run. In the case of telecommunications, the deterioration is monotonic, occurring in both short and long runs. In the case of transport, the mix of positive and negative short-run coefficients was

Table 2. Diagnostic tests of the linear model

	Diagnostic tests					Adj R ²	CS (CS ²)
	F-test	<i>t</i> -test	ECM _{t-1}	LM	Reset		
Construction	9.665**	-11.080**	-0.754**	0.081	0.319	0.502	S(S)
Financial services	8.685**	-4.024**	-0.792**	1.017	1.009	0.537	S(S)
Charges for the use of intellectual property	7.782**	-3.138	-0.781**	1.769	1.269	0.545	S(S)
Other business services	19.006**	-3.691**	-0.813**	1.423	0.150	0.382	S(S)
Telecommunications	3.487*	-1.864	-0.431**	0.591	0.001	0.347	S(S)
Transport	5.604**	-2.933	-0.578**	2.760	0.274	0.509	S(S)

Note(s): LM and reset represent the Lagrange multiplier test for autocorrelation and Ramsey test for misspecification. CS and CS² represent the Cumulative Sum and CUSUMSQ tests, with S and U representing stability and instability. (*) and (**) indicated significance at 10% and 5% levels

Source(s): Authors' own work

Table 3. Estimates of non-linear model

Category	Short-run estimates				Long-run estimates				
	POS	Sign. Lags	NEG	Sign. Lags	Yw	YJP	POS	NEG	COVID
Construction	-0.259 (2.182)	Nil	-1.767 (1.663)	Nil	0.413 (1.591)	-0.764 (1.193)	-0.593 (0.378)	-0.381 (0.372)	-0.195** (0.084)
Financial services	-3.348* (1.578)	0	-4.408** (1.191)	0, 2, 5-6, 9	-0.819 (1.834)	2.418** (1.177)	0.454 (0.362)	-0.094 (0.374)	0.121* (0.067)
Charges for the use of intellectual property	-0.147 (1.532)	Nil	-0.701 (1.210)	Nil	1.157 (1.535)	-2.227* (1.192)	0.906** (0.344)	0.485 (0.350)	-0.050 (0.070)
Other business services	-1.061 (0.995)	Nil	0.393 (0.762)	Nil	-0.297 (0.691)	-0.019 (0.537)	-0.426** (0.172)	-0.403** (0.168)	-0.035 (0.037)
Telecommunication	3.287** (1.504)	1	0.701 (1.174)	Nil	1.929** (1.051)	-0.027 (0.777)	-0.341 (0.245)	0.777** (1.234)	-0.024 (0.053)
Transport	-0.808* (0.469)	0	0.454 (0.374)	Nil	4.273** (2.002)	-0.789 (1.323)	0.360* (0.182)	0.707** (0.318)	0.157** (0.056)

Note(s): POS: positive; NEG: negative
Source(s): Authors' own work

accompanied by a positive long-run coefficient, possibly indicating an inverse J-curve. Overall, the non-linear ARDL model, like the linear ARDL model, did not provide support for the presence of the J-curve.

Like the linear ARDL models, the NARDL models were diagnostically satisfactory, with no serial correlation or misspecification and no co-integration null rejected in all cases except for other business services, and in the case of *t*-test, charges for charges for the use of intellectual property (Table 4). All systems, except for telecommunications were stable, either converging (financial services) or oscillating before convergence (other sectors).

With regard to asymmetry, the Wald-S test of cumulative asymmetry failed to reject the null hypothesis of the sum of the coefficients attached to ΔPOS_{t-j} being equal to ΔNEG_{t-j} (the absence of cumulative asymmetry) in the case of transport but failed to reject it for financial services and telecommunications. For construction, charges for the use of intellectual property and other business services, the test was not applied due to the absence of lags for ΔPOS_{t-i} and ΔNEG_{t-i} . In addition, the Wald-L test of the long-run asymmetry failed to identify this asymmetry pattern in any of the categories, except for financial services and transport. Overall, the evidence of asymmetry across the services' trade was weak.

The evidence of S-curves was limited in every category, with the exception of transport (Figure 1). In construction, the positive cross-correlation coefficients at lags of trade balance were accompanied by negative coefficients at leads, i.e. inverted S-curves. In the financial service category, the expected negative coefficient at lags was accompanied by a positive yet insignificant correlation at trade balance leads. In the case of payments for intellectual property, the positive correlation between exchange rate and trade balance was observed only at selected higher leads of the balance and was negative at most lags and leads. The inverted S-curve with significant positive correlation at lags of the balance and very limited and small positive correlations at higher leads was also observed for other business services categories. For telecommunications, the cross-correlation coefficient was positive at most leads and lags. In the transport category, the S-curve was likely present; however, the cross-correlation coefficient was positive at lags of zero to ten. In four categories except telecommunications and transport, the contemporaneous correlation was negative, in line with the HLM effect, attesting to negative effects of deterioration of relative prices of exports and imports on trade balance. The shifts in the sign and/or trends in cross-correlation coefficients took place at different time points across the categories, suggesting desynchronisation of responses to exchange rate changes across the categories.

Table 5 presents the effects of unconditional and conditional (GARCH-M-based) volatility on trade balance in the individual service categories. The nature of services trade, with emphasis on non-price competition, long-term contractual arrangements, a limited number of buyers and sellers and relatively large (compared to goods trade) trade barriers, suggests a limited effect of currency volatility. This was indeed the case, with significant coefficients only observed in telecommunications trade. The sign of coefficients is negative, suggesting the dominance of the substitution effect.

As Figure 2 demonstrates, the trade partner concentration ratios remained stable in each category, ranging between 0.5 and 0.7 (0.7 and 0.9 for the financial services). The ratio volatility was the highest for telecommunications, charges for the use of intellectual property and construction (in the latter case due to staged contracts and the large size of individual contracts). Ratios' stability was observed in financial and other business services (reflection of a bulk of trade with the US and the UK). The exchange rate fluctuations had a small effect on the dynamics of partners' ranks, except for construction and other business services' imports (Table 6). The significant effects of exchange rates on concentration ratios were observed in the imports of financial services, charges for the use of intellectual property, and telecommunications and exports of the former two services plus transport. Most of the significant effects were non-contemporaneous, i.e. taking one or two years to pass through to trade quantities.

Table 4. Diagnostic tests for non-linear model

	Diagnostic tests						CS (CS ²) ^c	Wald-S	Wald-L
	F-test	t-test	ECM _{t-1}	LM ^a	Reset ^b	Adj.R ²			
Construction	8.272**	11.236**	-0.767**	0.289	2.732**	0.486	S(S)	N/A	0.902
Financial services	6.676**	-3.985**	-0.806**	2.222**	0.000	0.594	S(S)	4.715**	6.269**
Charges for the use of intellectual property	4.542**	-3.569	-0.790**	3.743*	0.159	0.566	S(S)	N/A	2.333
Other business services	14.995**	-2.915	-0.812**	1.353	0.103	0.377	S(S)	N/A	0.055
Telecommunications	6.988**	-5.136**	-0.914**	1.688**	2.506**	0.496	S(S)	27.726**	1.517
Transport	4.213**	-4.549**	-0.394**	3.532*	0.490	0.434	S(S)	1.911	4.124**

Note(s): Both Wald Tests are distributed as χ^2 with one degree of freedom. (*) and (**) represent significance at the 10% and 5% levels, respectively

Source(s): Authors' own work

Table 5. Effects of exchange rate volatility on trade balance

Category		Unconditional volatility		Conditional volatility	
		Linear	Non-linear	Linear	Non-linear
Construction	Coeff	-0.723	-0.687	5.206	10.334
	<i>p</i> -value	0.721	0.744	0.546	0.103
Financial services	Coeff	0.488	0.987	-5.610	-18.873
	<i>p</i> -value	0.787	0.575	0.491	0.159
Charges for the use of IP	Coeff	0.825	0.958	2.665	2.359
	<i>p</i> -value	0.393	0.282	0.495	0.553
Other business services	Coeff	-0.073	-1.384	1.450	-0.300
	<i>p</i> -value	0.929	0.166	0.632	0.932
Telecommunication	Coeff	-3.613	-2.973	5.921	4.273
	<i>p</i> -value	0.217	0.068	0.525	0.560
Transport	Coeff	-0.719	0.036	-6.129	-0.602
	<i>p</i> -value	0.515	0.977	0.201	0.927

Note(s): Values in italic indicate significance at the 5% level. IP: Intellectual property

Source(s): Authors' own work

Table 6. Effects of exchange rate on trade partner concentration and rank dynamics

	Rank			Concentration ratio		
	Lag 0	Lag 1	Lag 2	Lag 0	Lag 1	Lag 2
<i>Imports</i>						
Construction	-0.513	-0.423	-0.318	0.027	0.186	0.368
Financial services	-0.407	-0.251	-0.131	-0.161	-0.525	-0.404
Charges for the use of IP	-0.216	-0.079	-0.064	0.624	0.533	0.460
Other business services	0.032	0.514	0.410	-0.023	-0.050	-0.136
Telecommunication	-0.382	-0.224	-0.395	-0.109	-0.500	-0.761
Transport	-0.022	0.288	0.447	0.286	-0.160	-0.063
<i>Exports</i>						
Construction	-0.175	-0.055	-0.259	-0.299	-0.209	0.055
Financial services	-0.155	0.126	0.090	-0.474	-0.342	-0.531
Charges for the use of IP	-0.251	-0.123	-0.099	0.108	0.218	0.534
Other business services	-0.381	0.065	-0.225	-0.229	0.232	0.234
Telecommunication	-0.304	-0.205	-0.406	-0.085	-0.180	-0.290
Transport	-0.303	0.210	0.285	-0.210	-0.590	-0.453

Note(s): As per Table 5

Source(s): Authors' own work

The limited sensitivity of trade partner structures to exchange rates is thus a reflection of gravity and proximity, whereby most of the trade is conducted with East Asian economies (transport), monopolisation of the sector, whereby trade is conducted with a limited number of firms in selected countries (financial and other business services) or pure commercial considerations, whereby it is profitable to trade with firms in economies that had not been previously major trading partners (construction). Exchange rate fluctuations play a limited role in these situations.

5. Discussions

5.1 Theoretical implications

The absence of asymmetries and the J-curve effect may be attributed to the following factors.

Firstly, while the price factor and the respective level of the exchange rate continue to be important (as in the case of goods' trade), the decision to purchase or sell a particular service also (and likely to a greater degree) depends on the nature of the services, the degree of service differentiation, the provision of adjacent services and other non-price factors (Cheng, 2021). Thus, the asymmetric response of prices to exchange rate movements is likely restricted to the goods' trade realm (Bussiere, 2013).

Secondly, the role of the change in traders' expectations to appreciations versus depreciations in the asymmetric (or, in fact, any) adjustment in the trade balance may be reduced in the Japanese context. The mechanism of entry and exit of the firms in response to exchange rate movements (in particular, the differential entry and exit rate in times of appreciations versus depreciations) and thus of asymmetric trade balance reactions, mentioned by Arize *et al.* (2017), may not be operational either in Japan. The Japanese service sector has long been understood to be comparatively inefficient, partly due to the strategic behaviour of oligopolies (Fukao, 2010). A relatively high (compared to other developed economies) degree of concentration (Flath, 2014), smaller intensity of price competition and the recourse to long-range planning and price setting (Hayashi, 1978) and restructuring and reorganisation as an alternative to exit and corporate bankruptcy likely undermine the role of expectations and exit of the firms in price and trade dynamics. In addition, the deflationary environment, slowdown in expected growth and deregulation created a shared understanding of the stability of the future prices and wages and further strengthened the consensus about employment preservation, as opposed to downward price adjustment, causing firms to rely less on the strategies of capturing market share by cutting prices and instead focus on maintaining the rate of return and prices and preserving the customer base (Uchida, 2024).

5.2 Managerial/policy implications

The implementation of the Abenomics set of macroeconomic policies (comprising monetary easing, fiscal stimuli and structural reforms to spur economic growth and move Japan from the deflationary trap) provided a "quasi-experiment" setting for the assessment of the effects of depreciating the yen on trade balance and economic growth. The "quasi-experiment" did not appear to improve trade balance in the long run, and the weaker yen did not translate into lower and more competitive export prices of Japanese products and higher export volumes and values. Shimizu and Sato (2014) attributed the weak evidence of the J-curve (particularly its long-term upward segment) to the cross-border expansion of production networks by Japanese companies. The effect of this restructuring was the growth of exports by the subsidiaries of Japanese companies from abroad (rather than from Japan) and the growth of imports of parts and components to Japan (the latter likely playing little role in the services trade).

The detachment between exchange rate (volatility) and trade balance and trade partner structure points to the limited role of exchange rate policy in correcting services imbalances (albeit it may not be the case of such policies in goods trade). On the other hand, given that there were limited effects of the exchange rate on both import and export sides, the detachment may also indicate limited negative effects associated with growing import costs and trade conflicts arising from currency manipulation.

Given sector-specific results with significant effects in some of them, the competitiveness-enhancing policies introduced *in lieu* of currency management will need to address the requirements of individual services sectors. Additional policies to regulate services trade will need to concern marketing activities, foreign investment (when exporting firms establish a presence in foreign markets) and regulation of services production supply chains.

In the trade partner composition realm, the salient policies that would matter *in lieu* of currency management include export promotion to diversify the partner base, services deregulation, services trade liberalisation in General Agreement on Trade in Services/WTO and, in the case of a limited number of partners, competition policy.

5.3 Limitations and future research agenda

The major limitation of the J-curve analysis is a partial equilibrium focus. The correction of the trade imbalances due to depreciation may take place, which may mask other policy and economic repercussions. Even with positive effects on trade balance ensured, there is no guarantee that the negative effects of depreciation on domestic production (e.g. increase in import costs and reduction in aggregate supply) will not outweigh the positive effects on trade and aggregate demand. Additionally, the fixation on external policy to increase economic growth may downplay the importance of much more difficult tasks such as improvements in labour productivity, upgrading economic structures and technological advancements to foster competitiveness.

Future research may need to examine more fine-grained service categories at a higher frequency, which may yield stronger evidence in favour of the J-curve. To differentiate the effects across Japan's trading partners, the future studies may need to consider bilateral trade in services. The incorporation of non-trade factors (quality of services, the buyer-supplier long-term contractual relations) may be needed given that they matter more for services than for goods. The industry and/or sector size may matter as well, given that small-sized industries are more sensitive to depreciation than large ones (Dixit, 1989). Lastly, the robust empirical research in the field may need to modify the original J-curve and Marshall–Lerner condition assumptions, formulated by Magee (1973), similar to an approach implemented by Welfens (2019).

6. Conclusions

The earlier research of the J- and S-curves gave conflicting results as to the presence or absence of the curve in trade balance following depreciation. These were attributed to the analysis at the aggregate trade level and to linearity assumptions that were embedded in the modelling. The subsequent studies attempted to address this problem by looking at bilateral and disaggregated trade using non-linear models, such as NARDL. This study, using ARDL and NARDL and correlation analysis for the disaggregated services trade of Japan using high-frequency monthly data, was not able to detect the J-curve effect in most of the categories, irrespective of the model used. It was not able to confirm asymmetries in the reactions of the trade balance to depreciation versus appreciation. Additionally, the very limited effects of yen volatility on trade balance and of yen depreciation on trade partner structure were identified. These results were attributed to the specific features of the trade in services, the nature of competition in Japan, the restructuring processes of Japanese corporations and the broader macroeconomic challenges of recent times.

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Notes

1. Morikawa (2015) notes that Japan was ranked fourth in goods exports and eighth in service exports in the 2010s, indicating a relatively salient presence in world service trade. Royalties and licence fees are the major export category (28.0% of the aggregate services exports in 2022), followed by other business services (27.0%) and transportation services (17.6%), a reflection of the prominent role of Japan in global shipping, international technological transfer and international licensing (UNCTAD, 2023). Service imports are likewise dominated by these three service categories (39.0% for other business services, 18.2% for transportation and 13.9% for royalties and licence fees) and also by computer and information services (11.2% of services trade). Travel, construction, government services and insurance played relatively modest roles in Japan's economy compared to other developed economies.
2. Di Nino *et al.* (2011)

3. The differences include simultaneity of production and consumption (and thus absence of intermediate inputs trade typical for manufacturing), substantially larger tariff and non-tariff barriers and more complex trade modes (cross-border supply, consumption abroad, commercial presence and presence of natural persons).
4. There is a high degree of autocorrelation in net exports due to persistence in technological shocks.
5. In the absence of adjustment, the value of the error coefficient is within the (0–2) range instead of the (0–1) range (Loayza and Ranciere, 2005).
6. I(0) and I(1), but not I(2) variables.
7. The notable studies include Kanno's (2021) study on the changes to Japanese industrial structure during the COVID-19 pandemic and Pianta's (2021) study on the comprehensive study of industrial change across the globe following the COVID-19 pandemic.

Supplementary material

The supplementary material for this article can be found online.

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