Original Article

# The Necessity of New Versions of Bilateral Trade Balances and COVID-19: The Nonlinear ARDL Approach for the USA and Japan

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**Abstract**

This study aims to reveal the need to reformulate new forms of Bilateral Trade Balances (BTBs) for a country rather than a traditional BTB. This is because the traditional BTB ratio, based on total exports and defined as the total exports/total imports ratio, cannot classify and quantify a BTB based on its economic impact content. It fails to classify because countries also export goods already imported (denotes re-export) besides exporting their domestic goods produced within the country (denotes domestic export). It also fails to quantify because, while domestic goods undergo a value-added process within a country, re-exported goods do not. In this context, for the first time, this study attempts to reformulate/reinvestigate new forms of BTBs as *production-related BTB*, based on domestic export and *non-production-related BTB*, based on re-export for the USA with Japan. Empirical findings confirm the necessity and cruciality of the proposed methodology in this study.

**JEL Codes:** F10, F14

**Keywords**

Production-related bilateral trade balance, non-production-related bilateral trade balance, Nonlinear ARDL Approach, the USA, Japan

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## Introduction

The USA has been experiencing the most enormous and persistent trade deficits with other countries since 1992, reaching a total of $16 trillion. On the other hand, Japan, with a $1.99 trillion trade surplus with the USA, is one of these countries in the same period (CB, 2021). Accordingly, periodic trade conflicts between the USA and Japan were partly a consequence of Japan's high-level import penetration into the US markets (Cohen et al., 2002; Marlin-Bennett et al., 1992; Sato, 1988; Thorbecke, 2008; Wickes, 2021). Therefore, these large trade deficits periodically deteriorated the US-Japan economic relationships (Cimino-Isaacs & Williams, 2020; Urata, 2020).

On the other hand, according to a survey conducted by Harvard University, while 47% of Americans believe that free trade leads to lower goods prices for US consumers, 53% think that this causes job losses in the country (CAPS, 2018). These close percentages clearly show that bilateral trade deficits and surpluses resulting from free trade should eventually be based on economic impact contents for the countries concerned. This means that the economic impact of a negative or a positive Bilateral Trade Balance (henceforth, BTB) might become more important than solely a country's negative or positive BTB ratios. For instance, the final economic contribution of a *production-related BTB*, based on domestic export,[1] might become lower for a country than the final economic contribution of a *non-production-related BTB*, based on re-export.[2] In other words, for some goods, a non-production-related BTB might contribute to a country's economy more than a production-related BTB even though the former does not undergo any value-added process in this country (Banerjee, 2019). Therefore, this complex structure requires creating new forms of BTBs rather than using a traditional aggregated BTB ratio, based on total export only, since total export includes domestic export and re-export. However, the lack of re-export data for many countries does not allow policymakers-scholars to make more accurate estimations in their trade policies-models. In this context, the USA is one of few countries that collect this data separately since the share of US re-exports to other countries came to 19.7% of total exports in 2020. As the fourth largest trade partner of the USA, Japan is one of the countries involved, with a share of 11.5% (CB, 2021).

Therefore, in this study, we, for the first time, propose to reformulate and re-investigate the BTBs of the USA with Japan in the forms of *production-related BTB* and *non-production-related BTB*, based, respectively, on domestic export and re-export separately. With these two forms of BTBs proposed, this methodology will be capable of quantifying BTBs based on economic impact content as opposed to *total-export BTB*. In this context, the main contribution of this study is to discover concealed but potentially existing, actual impacts of independent variables on the above-mentioned forms of BTBs since *total-export BTB* is not capable of detecting them. Hence, this methodology might allow policymakers to compare such impacts on negative-positive BTBs for the USA based on economic impact contents. This is so because a BTB can be positive (trade surplus) but in the form of *non-production-related BTB,* or a BTB can be negative (trade deficit) but in the form of *production-related BTB*. It is obvious that the contribution of *production-related BTB* to the economy will be larger than *non-production-related BTB*. Hence, this methodology will answer a crucial question of what kind of trade deficit the USA has, rather than a trade deficit only as a single value. This information can provide more efficient and sustainable trade policies to USA policymakers. Therefore, this study, using the methodology mentioned above, differs from all previous empirical studies that use the concept of BTB as a ratio of total export (x)/total imports (m) or m/x (Arize, 1994; Baek & Choi, 2020; Bahmani-Oskooee & Alse, 1994; Bahmani-Oskooee & Artatrana, 2004; Bahmani-Oskooee & Hegerty, 2009; Bahmani-Oskooee & Karamelikli, 2021; Gupta-Kapoor & Ramakrishnan, 1999; Hacker & Abdulnasser, 2003; Magee, 1973; Ongan & Gocer, 2021).

## *Empirical Model*

The empirical model of this study originates from the following most used form equation between a dependent variable and traditional independent variables for the USA. Additionally, as the second contribution of this study is that, in this model, we add trade policy uncertainty (TPU) indexes for US $(TPU_{US})$ and Japan $(TPU_{JPN})$ and the COVID-19 pandemic. This index will reveal how changes in these indexes separately affect US BTBs. Similarly, we assume that the COVID-19 pandemic, as a game-changer for international trade, affects US BTBs with Japan (Sinha, 2020):

$$\frac{X_{US-JPN}}{M_{US-JPN}} = \beta_0 + \beta_1 LnY_{US_t} + \beta_2 LnY_{JPN_t} + \beta_3 RER_{YEN-USD_t} + \beta_4 TPU_{US_t} + \beta_5 TPU_{JPN_t} + \beta_6 D_{Covid_t} + e_t \tag{1}$$

Following Equation (1), we re-construct the model above based on the methodology proposed in this study by adding the new version forms of BTBs (dependent variables) BTBs as *production-related BTB* and *non-production-related BTB*. To show this proposed methodological approach clearly, we present the following model in a non-logarithmic form; however, we estimate the model with logarithmic variables:

$$\left(\underbrace{\frac{X_{US-JPN}}{M_{US-JPN}}}_{A}\right) = \left(\underbrace{\frac{X^{p}_{US-JPN}}{M_{US-JPN}}}_{C}\right) + \left(\underbrace{\frac{X^{np}_{US-JPN}}{M_{US-JPN}}}_{D}\right) = \beta_0 + \beta_1 Y_{US_t} + \beta_2 Y_{JPN_t} + \beta_3 RER_{YEN-USD_t} + \beta_4 TPU_{US_t} + \beta_5 TPU_{JPN_t} + \beta_6 D_{Covid_t} + e_t \tag{2}$$

since $X_{US-JPN}$ (*total-export*) = $X^{p}_{US-JPN}$ (*production-related* export = domestic export) + $X^{np}_{US-JPN}$ (*non-production-related* export = re-export). Hence, $\frac{X_{US-JPN}}{M_{US-JPN}}$, $\frac{X^{p}_{US-JPN}}{M_{US-JPN}}$ and $\frac{X^{np}_{US-JPN}}{M_{US-JPN}}$ are *total-export BTB* (denotes A in Equation 2), *production-related*

*BTB (denotes C)* and *non-production-related BTB (denotes D)*, respectively. $X_{US-JPN}$ is US export to Japan and $M_{US-JPN}$ is US imports from Japan. $Y_{US_t}$ and $Y_{JPN_t}$ are incomes of the USA and Japan. The industrial production index for monthly income is used as a proxy of income for both countries. $RER_{YEN-USD_t}$ is real exchange rate adjusted by CPIs. It is defined as $RER_{YEN-USD_t} = \frac{NEX_t * CPI_t^{JPN}}{CPI_t^{US}}$ since the *NEX* is nominal exchange rate as units of USD per YEN (Thorbecke, 2008). $TPU_{JPN}$ and $TPU_{US}$ are Japan's and US's TPU indexes, respectively. $D_{Covid_t}$ is the COVID-19 pandemic, defined as a dummy variable that takes the value of 1 since March 2020. The US and Japan's TPU indexes were created by Baker et al. (2016) and Arbatli et al. (2017), respectively. For the sake of brevity, the technical construction of the TPU index is explained in the Appendix. The rationale of using the TPU index as an additional independent variable in the model reflects our assumption that changes in uncertainties in trade policies of both countries may directly affect trade volumes and, thereby, the BTBs of the USA with Japan. It should also be noted that according to Hofstede (1980) and Kim (2006), Japanese people are one of the highest uncertainty avoidance people. Therefore, this result will necessitate adding the TPU index in a trade model that includes Japan. The expected sign of $\beta_1$ is to be negative since a rise in US income will lead to an increase in USA's imports from Japan that will worsen the USA BTBs (A, C and D). The expected sign of $\beta_2$ is to be positive since a rise in Japan's income will lead to an increase in USA's export to Japan that will improve the USA BTBs (A, C and D) with Japan. We expect the sign of $\beta_3$ to be positive since a real depreciation (an increase in RER) in the USD will lead to an increase in USA's export to Japan that will improve the USA's BTBs (A, C and D) with this country (Nakashima, 2008). The expected signs of $\beta_4$ and $\beta_5$ can be either positive or negative and thereby they may improve or worsen A, C and D. Similarly, we expect the sign of $\beta_6$ to be either positive or negative since the COVID-19 pandemic can improve or worsen US BTBs. This study uses 44 leading *Harmonized System* (*HS*) coded goods between the USA and Japan. The monthly industry flows between 2002M1 and 2021M7 were obtained from the US Census Bureau. The nominal exchange rates, CPIs and IPI indexes were obtained from the Federal Reserve Bank of St. Louis (2021).

## *Empirical Methodology*

To reveal the separate impacts of increases (+) and decreases (–) in US's $\left(TPU_{US_t}^{+}, TPU_{US_t}^{-}\right)$ and Japan's $\left(TPU_{JPN_t}^{+}, TPU_{JPN_t}^{-}\right)$ TPU indexes on A, C and D, we apply the Nonlinear Autoregressive Distributed Lag (NARDL) approach introduced by Shin et al. (2014). This approach allows for potential asymmetries concerning both increases and decreases in an independent variable (TPU index) since the impacts of $TPU_{JPN_t}^{+}, TPU_{JPN_t}^{-}, TPU_{US_t}^{+}$ *and* $TPU_{US_t}^{-}$ on A, C and D can be asymmetric (nonlinear). Asymmetry is defined as the different magnitude or different sign (direction) effects of $TPU^{+}_{JPN_t}, TPU^{-}_{JPN_t}, TPU^{+}_{US_t}$ *and* $TPU^{-}_{US_t}$ on A, C and D. Before applying the NARDL approach, we, first, decompose the TPU indexes of both countries into their increases $(TPU^{+})$ and decreases $(TPU^{-})$ using the following consecutive equations developed by Granger and Yoon (2002):

$$TPU_t = TPU_{t-1} + \varepsilon_t = TPU_0 + \sum_{j=1}^{t} \varepsilon_j \tag{3}$$

where $TPU_0$ shows initial value of $TPU$. $\varepsilon_t \sim N\left(0, \sigma^2_{\varepsilon_t}\right)$ is white noise error term. Positive and negative shocks can be defined as:

$$\varepsilon^{+}_t = max\left(\varepsilon_t, 0\right) \tag{4}$$

$$\varepsilon^{-}_t = min\left(\varepsilon_t, 0\right) \tag{5}$$

Since the error term can be defined as $\varepsilon_t = \varepsilon^{+}_t + \varepsilon^{-}_t$, we can rewrite Equation (3) as following:

$$TPU_t = TPU_{t-1} + \varepsilon_t = TPU_0 + \sum_{j=1}^{t} \varepsilon^{+}_t + \sum_{j=1}^{t} \varepsilon^{-}_t \tag{6}$$

so, we can define the positive and negative shocks of TPU as:

$$TPU^{+}_t = \sum_{j=1}^{t} \varepsilon^{+}_t \tag{7}$$

$$TPU^{-}_t = \sum_{j=1}^{t} \varepsilon^{-}_t \tag{8}$$

if we set the equation based on $\varepsilon_t$ in Equation (3):

$$\varepsilon_t = TPU_t - TPU_{t-1} = \Delta TPU_t \tag{9}$$

we obtain the following equations when we add $\Delta TPU_t$ in Equations (7) and (8):

$$TPU^{+}_t = \sum_{j=1}^{t} \Delta TPU^{+}_j = \sum_{j=1}^{t} \max\left(\Delta TPU_j, 0\right) \tag{10}$$

$$TPU^{-}_t = \sum_{j=1}^{t} \Delta TPU^{-}_j = \sum_{j=1}^{t} \min\left(\Delta TPU_j, 0\right) \tag{11}$$

where $TPU_t^+$ and $TPU_t^-$ are the partial sum process of positive (+) and negative (–) changes in the TPU index. After this decomposition process, we re-write the model in Equation (2) in the following NARDL approach to estimate the coefficients of the *total-export BTB* (denotes A), *production-related BTB* (denotes C) and *non-production-related BTB* (denotes D) models, separately.

$$\begin{aligned}\Delta BTB_{US\_JPN_t} = {} & \beta_0 + \beta_1 BTB_{US\_JPN_{t-1}} + \beta_2 Y_{US_{t-1}} + \beta_3 Y_{JPN_{t-1}} + \\ & \beta_4 RER_{YEN\_USD_{t-1}} + \beta_5 TPU^+_{US_{t-1}} + \beta_6 TPU^-_{US_{t-1}} + \\ & \beta_7 TPU^+_{JPN_{t-1}} + \beta_8 TPU^-_{JPN_{t-1}} + \sum_{j=1}^{m_1} \beta_{10j} \Delta TTB_{US\_JPN_{t-j}} + \\ & \sum_{j=0}^{m_2} \beta_{11j} \Delta Y_{US_{t-j}} + \sum_{j=0}^{m_3} \beta_{12j} \Delta Y_{JPN_{t-j}} + \sum_{j=0}^{m_4} \beta_{13j} \Delta RER_{YEN\_USD_{t-j}} + \\ & \sum_{j=0}^{m_5} \beta_{14j} TPU^+_{US_{t-j}} + \sum_{j=0}^{m_6} \beta_{15j} TPU^-_{US_{t-j}} + \sum_{j=0}^{m_7} + \beta_{16j} TPU^+_{JPN_{t-j}} + \\ & \sum_{j=0}^{m_8} \beta_{17j} TPU^-_{JPN_{t-j}} + \beta_{18} D_{Covid_{t-1}} + \epsilon_t \end{aligned} \tag{12}$$

In Equation (12), the long-run impacts of US and Japan's $TPU_t^+$ and $TPU_t^-$ indexes on US BTBs (A, C and D) are determined by the signs and significances of normalised $\frac{-\beta_5}{\beta_1}$, $\frac{-\beta_6}{\beta_1}$, $\frac{-\beta_7}{\beta_1}$ and $\frac{-\beta_8}{\beta_1}$, respectively. Similarly, we determine the long-run impacts of the $Y_{US_t}$, $Y_{JPN_t}$ and $RER_{YEN\_UDS_t}$ by the signs and significances of normalised $\frac{-\beta_2}{\beta_1}$, $\frac{-\beta_3}{\beta_1}$ and $\frac{-\beta_4}{\beta_1}$, respectively. The short-run impacts of $TPU_t^+$ and $TPU_t^-$ indexes are determined by the signs and significances of $\sum_{j=0}^{m_5} \beta_{14j}$, $\sum_{j=0}^{m_6} \beta_{15j}$, $\sum_{j=0}^{m_7} \beta_{16j}$ and $\sum_{j=0}^{m_8} \beta_{17j}$. For formal decisions of short-run asymmetry ($W_{SR}$) and long-run asymmetry ($W_{LR}$), we apply the Wald test and determine $\sum_{j=0}^{m_5} \beta_{14j} = \sum_{j=0}^{m_6} \beta_{15j}$, $\sum_{j=0}^{m_7} \beta_{16j} = \sum_{j=0}^{m_8} \beta_{17j}$, and $\frac{-\beta_5}{\beta_1} = \frac{-\beta_6}{\beta_1}$ and $\frac{-\beta_7}{\beta_1} = \frac{-\beta_8}{\beta_1}$. The null hypothesis of the Wald test is symmetry.

## Empirical Findings

We provide the estimations of normalised long-run coefficients and diagnostics of the NARDL model in the following Tables 1–3 for *production-related*

**Table 1.** The Nonlinear ARDL Model Estimation Results (Normalised Long-run Coefficient for Production-related BTB: $X^p$).

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^-_{US}$ | $TPU^+_{US}$ | $TPU^-_{JPN}$ | $TPU^+_{JPN}$ | $D_{Covid}$ | $\bar{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W^{TPU\_US}_{SR}$ | $W^{TPU\_JPN}_{SR}$ | $W^{TPU\_US}_{LR}$ | $W^{TPU\_JPN}_{LR}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **22 Beverages, Spirits and Vinegar** | –16.23[b] | 7.44[c,i] | –2.64 | 0.71 | 0.24 | 0.09 | –0.06 | 0.08 | 0.07 | 0.46 | 0.01 | 0.71 | 3.1 | –0.36 | S | 3.63[c,as] | 0.76 | 2.46 | 1.59 |
| **28 Inorg Chem, Radioact Compd** | 23.40[c] | –5.44[b,w] | 0.02 | –0.43 | –0.41[c,i] | –0.25[c,w] | –0.10 | –0.29[a,w] | –0.47[c,w] | 0.37 | 0.11 | 1.44 | 5.91[a] | –0.44[a] | S | 0.008 | 0.84 | 3.07[c,as] | 3.01[c,as] |
| **29 Organic Chemicals** | –5.42 | –1.63 | 2.76[a,i] | 0.04 | 0.16[b,w] | 0.10 | –0.16 | –0.06 | 0.02 | 0.5 | 0.29 | 0.03 | 2.41 | –0.39 | S | 0.08 | 10.43[a,as] | 0.72 | 1.36 |
| **30 Pharmaceutical Products** | –23.73[b] | 10.29[c,i] | –1.43 | 3.74[c,i] | –0.23[a,i] | –0.36[c,w] | –0.23 | –0.02 | –0.08 | 0.36 | 0.02 | 0.09 | 2.73 | –0.29 | S | 0.48 | 0.04 | 1.42 | 2.13 |
| **32 Tanning, Dye Ext, Paint, Putty, Inks** | –13.94 | –11.84 | 13.32 | –1.33 | 0.02 | –0.30 | 0.05 | 0.46 | 0.15 | 0.57 | 1.88 | 0.17 | 4.40[b] | –0.19 | S | 1.98 | 7.96[a,as] | 1.05 | 1.12 |
| **33 Essential Oils, Perfumery, Cosmetic** | –2.57 | 4.64[c,i] | –2.78[c,w] | 0.85[c,i] | –0.04 | –0.05 | 0.02 | 0.01 | 0.15 | 0.53 | 1.52 | 0.38 | 4.05[b] | –0.85[a] | S | 2.65 | 3.67[c,as] | 0.17 | 0.08 |
| **35 Albuminoidal Subst, Glue, Enzymes** | 6.62[b] | –1.29 | 0.007 | 0.18 | –0.01 | 0.03 | –0.11[b,i] | –0.16[c,w] | –0.14 | 0.46 | 0.22 | 0.38 | 10.75[a] | –0.79[a] | S | 0.06 | 6.09[b,as] | 2.42 | 2.14 |
| **37 Photographic or Cinematog. Goods** | 10.78 | –3.31 | 0.24 | –0.24 | –0.03 | 0.07 | –0.05 | –0.17 | –0.07 | 0.37 | 0.76 | 0.25 | 2.35 | –0.31 | S | 1.32 | 2.2 | 1.93 | 2.25 |
| **38 Miscellaneous Chemical Products** | –1.11 | –0.29 | 0.31 | –0.21 | 0.03 | –0.05[b,w] | –0.03 | 0.06 | –0.09 | 0.47 | 0.69 | 3.34 | 8.51[a] | –0.75[a] | S | 2.81[c,as] | 1.48 | 12.17[a,as] | 12.24[a,as] |
| **39 Plastics and Articles Thereof** | 5.56 | –5.21[a,w] | 4.04[b,i] | 0.25 | –0.01 | 0.01 | –0.15 | –0.16 | –0.06 | 0.52 | 0.02 | 0.63 | 3.64[c] | –0.22 | S | 0.18 | 1.27 | 0.22 | 0.03 |
| **40 Rubber and Articles Thereof** | –11.33[c] | –0.73 | 2.33[c,i] | –0.39[c,w] | 0.13[c,w] | 0.08[c,i] | –0.01 | 0.04 | 0.31[c,i] | 0.46 | 0.01 | 0.03 | 6.43[a] | –1.05[a] | S | 9.26[a,as] | 0.92 | 5.04[b,as] | 4.14[b,as] |
| **42 Leather Art, Handbags, Gut Art** | 11.65[a] | 2.15 | –3.30[b,w] | 0.86[c,i] | –0.05 | –0.09 | –0.04 | –0.006 | –0.59[c,w] | 0.45 | 0.41 | 0.4 | 3.62[c] | –0.50[c] | S | 0.04 | 1.21 | 0.32 | 0.22 |

*(Table 1 continued)*

(Table 1 continued)

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^{-}_{US}$ | $TPU^{+}_{US}$ | $TPU^{-}_{JPN}$ | $TPU^{+}_{JPN}$ | $D_{Covid}$ | $\overline{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | $Cusum$ | $W^{TPU\_US}_{SR}$ | $W^{TPU\_JPN}_{SR}$ | $W^{TPU\_US}_{LR}$ | $W^{TPU\_JPN}_{LR}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **44 Wood, Articles Wood** | −15.73$^{b}$ | 4.30 | 0.71 | 0.45 | −0.08 | −0.37$^{c,w}$ | 0.25 | 0.57$^{c,i}$ | 0.04 | 0.41 | 0.37 | 0.44 | 3.37$^{c}$ | −0.41$^{b}$ | S | 1.79 | 2.94$^{c,as}$ | 12.20$^{a,as}$ | 10.96$^{a,as}$ |
| **48 Paper, Paperboard** | 11.06$^{b}$ | −1.39 | −0.85 | 0.21 | −0.25$^{b,i}$ | −0.10$^{b,w}$ | 0.49$^{b,w}$ | 0.30$^{b,i}$ | 0.06 | 0.57 | 1.3 | 0.94 | 4.17$^{b}$ | −0.45 | S | 10.67$^{a,as}$ | 15.19$^{a,as}$ | 2.80$^{c,as}$ | 2.58 |
| **49 Printed Books, Newspapers, Manusc.** | 14.82$^{c}$ | 3.70$^{b,i}$ | −5.11$^{c,w}$ | 1.58$^{c,i}$ | 0.21$^{c,w}$ | 0.23$^{c,i}$ | −0.15 | −0.17 | −0.31$^{b,w}$ | 0.58 | 0.04 | 0.6 | 5.23$^{a}$ | −0.70 | S | 0.95 | 0.06 | 0.07 | 0.09 |
| **56 Wadding, Felt, Yarn, Twine, Ropes** | 7.12 | −1.80 | 1.51 | 1.38$^{c,i}$ | −0.01 | −0.11 | 0.002 | 0.12 | 0.04 | 0.48 | 0.06 | 3.42 | 2.92 | −0.48 | S | 6.45$^{b,as}$ | 0.00001 | 1.8 | 1.68 |
| **59 Impregnated, Text Fabrics** | −10.43$^{c}$ | 3.00$^{c,i}$ | −1.75$^{b,w}$ | −0.87$^{c,w}$ | 0.05 | −0.004 | −0.10 | −0.05 | −0.19 | 0.46 | 0.02 | 5.1 | 5.06$^{a}$ | −0.89$^{a}$ | S | 0.12 | 1.99 | 2.82$^{c,as}$ | 1.73 |
| **61 Apparel Articles, Accessories, Crochet** | 29.86 | −4.67 | 7.96 | 10.42$^{b,i}$ | −0.39 | 0.05 | −0.86 | −1.29 | −0.50$^{b,w}$ | 0.33 | 4.98$^{c}$ | 0.64 | 2.19 | −0.12 | S | 1.42 | 1.2 | 0.96 | 0.65 |
| **62 Apparel Articles** | 4.42 | −0.41 | 2.15 | 2.27$^{b,i}$ | 0.18 | −0.14 | −0.25 | 0.14 | 0.13 | 0.57 | 0.19 | 1.21 | 2.39 | −0.29 | S | 0.91 | 0.04 | 2.94$^{c,as}$ | 2.95$^{c,as}$ |
| **63 Textile Art Nesoi, Needlecraft Sets** | 9.94 | −0.76 | −1.51 | −0.10 | −0.20 | 0.10 | −0.01 | −0.38$^{b,w}$ | −0.44$^{c,w}$ | 0.45 | 7.78$^{a}$ | 0.09 | 3.62$^{c}$ | −0.38$^{b}$ | S | 0.38 | 0.36 | 9.23$^{a,as}$ | 9.56$^{a,as}$ |
| **64 Footwear, Gaiters Etc. And Parts Thereof** | 20.52 | −1.51 | 0.38 | 2.87$^{c,i}$ | −0.04 | −0.06 | −0.29 | −0.24 | −0.69$^{b,w}$ | 0.4 | 0.08 | 1.48 | 4.17$^{b}$ | −0.49$^{a}$ | S | 1.68 | 1.01 | 0.02 | 0.08 |
| **65 Headgear and Parts Thereof** | −1.74 | 3.97 | −4.10 | −0.51 | 0.002 | −0.06 | 0.04 | 0.10 | −0.33 | 0.51 | 0.02 | 0.09 | 1.38 | -0.50 | S | 1.43 | 1.19 | 0.24 | 0.16 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **68 Art of Stone, Plaster, Cement, Mica** | −4.45 | 0.66 | 0.26 | 0.21 | −0.15[c,i] | −0.09[b,w] | 0.17[b,w] | 0.09 | −0.17 | 0.38 | 0.04 | 0.58 | 10.06[a] | −0.74[a] | S | 3.46[c,as] | 0.81 | 2.94[c,as] | 3.13[c,as] |
| **69 Ceramic Products** | 20.81[a] | −8.13[a,w] | 3.54 | 0.52 | −0.29[a,i] | −0.10 | 0.26 | 0.05 | −0.29 | 0.45 | 2.1 | 0.05 | 1.6 | −0.35 | S | 0.03 | 0.05 | 1.7 | 1.44 |
| **70 Glass, Glassware** | −15.90 | 1.77 | 0.77 | −1.13 | 0.48 | 0.33 | −0.34 | −0.17 | 0.07 | 0.41 | 0.53 | 0.1 | 2.46 | −0.13 | S | 4.87[b,as] | 0.21 | 0.48 | 0.47 |
| **71 Nat Pearls, Prec Stones, Met, Coin** | −1.75 | 0.07 | −0.75 | −1.31[a,w] | 0.23 | 0.35[c,i] | −0.52[b,i] | −0.65[c,w] | −0.41[a,w] | 0.4 | 0.12 | 0.16 | 2.89 | −0.47 | S | 2.93[c,as] | 0.58 | 1.17 | 1.08 |
| **72 Iron and Steel** | 12.63 | −12.58[a,w] | 7.77 | −1.20 | −0.42 | −0.27 | 0.23 | 0.06 | −0.11 | 0.42 | 0.2 | 0.76 | 1.73 | −0.19 | S | 5.12[b,as] | 0.31 | 0.49 | 0.41 |
| **73 Articles of Iron Steel** | −2.97 | −2.34[c,w] | 1.02[a,i] | −1.51[c,w] | 0.07[b,w] | 0.10[c,i] | 0.002 | −0.03 | 0.06 | 0.53 | 0.03 | 2.34 | 4.94[a] | −0.79[a] | S | 1.02 | 0.93 | 0.95 | 0.88 |
| **74 Copper and Articles Thereof** | 6.09 | −1.01 | 1.36 | 1.94[c,i] | 0.0007 | 0.006 | −0.48[b,i] | −0.4[c,w] | 0.01 | 0.42 | 0.01 | 0.02 | 3.51[c] | −0.36[c] | S | 1.31 | 0.14 | 0.004 | 0.08 |
| **76 Aluminum and Articles Thereof** | 7.73 | 1.26 | −2.32 | 0.86 | −0.17 | 0.10 | −0.02 | −0.34 | −0.27[b,w] | 0.36 | 0.64 | 2.41 | 1.08 | −0.13 | S | 2.80[c,as] | 1.13 | 1.76 | 1.66 |
| **82 Tools, Cutlery, Metal, Parts Thereof** | 0.60 | −1.67 | 0.99 | −0.004 | −0.14[c,i] | −0.08[b,w] | 0.01 | −0.06 | −0.28[b,w] | 0.28 | 0.03 | 0.89 | 10.84[a] | −0.67[a] | S | 2.75[c,as] | 0.93 | 2.26 | 2.14 |
| **83 Miscellaneous Articles of Base Metal** | −15.73 | 3.80 | −1.52 | −0.96 | 0.007 | −0.11 | −0.25 | −0.10 | −0.09 | 0.21 | 0.12 | 0.31 | 1.42 | −0.18 | S | 2.38 | 0.01 | 0.56 | 0.6 |

*(Table 1 continued)*

(Table 1 continued)

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^{-}_{US}$ | $TPU^{+}_{US}$ | $TPU^{-}_{JPN}$ | $TPU^{+}_{JPN}$ | $D_{Covid}$ | $\overline{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_US}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **84 Nuclear Reactors, Boilers, Machinery** | −2.32[a] | −2.27[c,w] | 0.89[b,i] | −1.60[c,w] | 0.12[c,w] | 0.04[b,i] | −0.06[c,i] | 0.03 | 0.21[c,i] | 0.54 | 3.34[c] | 2.65 | 9.76[a] | −0.97[a] | S | 0.97 | 0.09 | 30.64[a,as] | 27.27[a,as] |
| **85 Electric Machinery, Sound Equip, Tv Eq.** | −5.99[a] | 3.55[b,i] | −2.91[b,w] | −0.51[a,w] | 0.10[a,w] | −0.02 | −0.07 | 0.05 | 0.01 | 0.54 | 0.82 | 0.27 | 3.85[b] | −0.39 | S | 1.11 | 0.38 | 6.17[b,as] | 5.06[b,as] |
| **86 Railway, Tramway, Traffic Signal Equip** | 15.58 | −2.50 | −2.20 | −1.02 | 0.41 | 0.59[c,i] | 0.31 | 0.04 | 0.20 | 0.42 | 1.46 | 2.12 | 2.23 | −0.30 | S | 1.33 | 1.77 | 0.62 | 0.95 |
| **87 Vehicles, Except Railway or Tramway** | −4.18 | 0.87 | −0.32 | 0.26 | 0.08 | 0.02 | −0.02 | 0.04 | 0.17[a,i] | 0.49 | 0.03 | 0.82 | 4.65[b] | −0.48[a] | S | 3.38[c,as] | 4.14[b,as] | 1.94 | 1.67 |
| **88 Aircraft, Spacecraft, Parts Thereof** | 4.35 | −1.96 | 1.04 | −0.30 | 0.05 | 0.13[b,i] | 0.16[a,w] | 0.03 | 0.36[a,i] | 0.46 | 0.78 | 1.17 | 6.63[a] | −0.81[a] | S | 0.04 | 0.45 | 1.99 | 3.85[c,as] |
| **90 Optic, Medic, Surgical Instruments** | 1.10 | 0.31 | 0.02 | 0.62 | −0.08 | −0.04 | 0.11 | 0.06 | −0.02 | 0.56 | 3.39 | 0.79 | 1.01 | −0.15 | S | 0.35 | 0.18 | 0.24 | 0.27 |
| **91 Clocks, Watches and Parts Thereof** | 15.03 | −5.88[a,w] | 3.71[a,i] | 2.16[c,i] | 0.07 | 0.02 | −0.49[b,i] | −0.38[a,w] | −0.49[b,w] | 0.34 | 1.9 | 0.35 | 4.68[b] | −0.43[a] | S | 0.23 | 0.06 | 0.23 | 0.82 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **92 Musical Instruments, Accessories Thereof** | $-14.93^{c}$ | $3.58^{b,i}$ | 0.49 | $1.04^{b,i}$ | $-0.12^{b,i}$ | $-0.19^{c,w}$ | 0.01 | $0.12^{a,i}$ | 0.11 | 0.47 | 0.29 | 5.71 | $4.47^{b}$ | −0.58 | S | 1.84 | 0.02 | 2.69 | $4.77^{b,as}$ |
| **94 Furniture; Bedding Lamps Nesoi, Prefab** | 8.06 | −0.33 | −1.95 | −0.86 | $0.27^{b,w}$ | 0.10 | 0.08 | 0.25 | 0.10 | 0.34 | 2.08 | 0.02 | 2.47 | −0.24 | S | $3.62^{c,as}$ | 0.94 | $2.78^{c,as}$ | 2.05 |
| **95 Toys, Games, Sport Equip., Accessories** | $-26.05^{b}$ | $12.69^{c,i}$ | $-8.23^{b,w}$ | $-1.46^{a,w}$ | 0.18 | −0.06 | 0.12 | 0.40 | −0.02 | 0.31 | 0.99 | 0.19 | 2.81 | −0.36 | S | 1.17 | 1.02 | $3.39^{c,as}$ | $3.03^{c,as}$ |
| **96 Miscellaneous Manufactured Articles** | $-8.23^{c}$ | $2.55^{b,i}$ | −1.02 | 0.16 | 0.06 | $0.07^{b,i}$ | $-0.10^{a,i}$ | $-0.14^{b,w}$ | −0.07 | 0.48 | 0.05 | 0.8 | $12.74^{a}$ | $-0.99^{a}$ | S | 0.19 | 0.32 | 0.15 | 0.59 |
| **97 Art, Collectors' Pieces and Antiques** | $10.90^{b}$ | $-12.39^{c,w}$ | $7.08^{c,i}$ | $-2.69^{c,w}$ | $0.11^{a,w}$ | $0.17^{c,i}$ | 0.15 | 0.07 | $1.13^{b,i}$ | 0.6 | 0.83 | 1.71 | $5.44^{a}$ | $-1.88^{a}$ | S | 0.06 | $3.26^{c,as}$ | 1.21 | 1.38 |

**Table 2.** The Nonlinear ARDL Model Estimation Results (Normalised Long-run Coefficient for Non-production-related BTB: $X^{np}$).

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^-_{US}$ | $TPU^+_{US}$ | $TPU^-_{JPN}$ | $TPU^+_{JPN}$ | $D_{Covid}$ | $\bar{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_JPN}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **22 Beverages, Spirits and Vinegar** | 5.32 | −0.90 | −2.88 | −2.91[a,w] | 0.31[c,w] | 0.02 | 0.46 | 0.73[b,i] | 0.56 | 0.46 | 2.13 | 1.29 | 8.21[a] | −0.73[a] | S | 8.78[a,as] | 5.33[b,as] | 3.73[c,as] | 2.15 |
| **28 Inorg Chem, Radioact Compd** | −22.27 | −11.21 | 12.36[c,i] | −3.50 | 0.33 | −0.35 | 0.59 | 1.37[b,i] | 1.23[b,i] | 0.41 | 0.89 | 0.62 | 3.36[c] | −0.36 | S | 8.67[a,as] | 3.99[b,as] | 4.50[b,as] | 4.19[b,as] |
| **29 Organic Chemicals** | −12.93 | −4.14 | 4.86[b,i] | −0.93 | −0.02 | −0.12 | −0.0007 | 0.15 | 0.65[c,i] | 0.49 | 0.09 | 0.44 | 3.84[b] | −0.64[a] | S | 0.37 | 3.10[c,as] | 0.63 | 0.99 |
| **30 Pharma-ceutical Products** | −51.17[a] | 22.47[b,i] | −6.98 | 5.27[a,i] | −0.13 | −0.47[a,w] | −0.49 | 0.03 | −0.28 | 0.35 | 0.14 | 0.36 | 3.88[b] | −0.48[b] | S | 0.41 | 4.22[b,as] | 3.83[c,as] | 5.93[b,as] |
| **32 Tanning, Dye Ext, Paint, Putty, Inks** | −15.65 | 3.32 | −5.08 | −4.75[a,w] | 0.29 | 0.20 | −0.26 | −0.21 | 0.32 | 0.5 | 0.42 | 2.53 | 2.51 | −0.41 | S | 1.87 | 1.53 | 0.19 | 0.05 |
| **33 Essential Oils, Perfumery, Cosmetic** | −2.85 | −1.94 | 1.06 | −1.25 | 0.13 | −0.10 | 0.48 | 0.74 | 0.63[b,i] | 0.33 | 0.5 | 0.45 | 1.89 | −0.28 | S | 0.19 | 0.98 | 1.23 | 1.04 |
| **35 Albuminoidal Subst, Glue, Enzymes** | 12.16 | −4.10 | 2.61 | 2.32[b,i] | 0.11 | 0.14 | −0.25 | −0.24 | −0.17 | 0.39 | 2.2 | 0.36 | 7.04[a] | −0.60[a] | S | 0.02 | 0.16 | 0.06 | 0.0002 |
| **37 Photographic or Cinematog. Goods** | −19.02 | 9.93[c,i] | −7.06[b,w] | −0.68 | 0.29 | −0.22 | −0.24 | 0.36 | 0.04 | 0.38 | 1.75 | 1.48 | 4.74[a] | −0.44[a] | S | 0.27 | 0.26 | 9.53[a,as] | 9.14[a,as] |
| **38 Miscellaneous Chemical Products** | 46.35[a] | −18.72[a,w] | 5.20[c,i] | −2.20[b,w] | 0.12 | 0.18 | −0.16 | −0.19 | −0.64[c,w] | 0.5 | 0.0003 | 0.09 | 5.50[a] | −0.66[a] | S | 0.16 | 1.58 | 0.31 | 0.07 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **39 Plastics and Articles Thereof** | –4.08 | 1.74 | –1.44 | 0.08 | –0.06 | –0.01 | 0.12[c,w] | 0.05 | –0.003 | 0.5 | 0.12 | 0.44 | 3.72[c] | –0.60[b] | S | 0.95 | 2.33 | 1.54 | 1.8 |
| **40 Rubber and Articles Thereof** | –7.32 | 1.78 | –1.95 | –0.60 | 0.16 | –0.02 | 0.22 | 0.44 | 0.34 | 0.46 | 6.66[a] | 3.03[c] | 1.59 | –0.39 | S | 0.09 | 0.15 | 1.69 | 1.86 |
| **42 Leather Art, Handbags, Gut Art** | 18.88[b] | 7.15[b,i] | –8.99[a,w] | 1.66[b,i] | –0.08 | –0.25[a,w] | 0.28[c,w] | 0.47[b,i] | 0.15 | 0.43 | 0.46 | 0.1 | 6.93[a] | –0.49[a] | S | 0.22 | 5.49[b,as] | 3.29[c,as] | 2.86[c,as] |
| **44 Wood, Articles Wood** | –40.81[b] | 7.98 | 1.86 | 0.76 | –0.21 | –0.45[a,w] | 0.11 | 0.34 | 0.06 | 0.37 | 0.005 | 2.82[c] | 3.59[c] | –0.50[a] | S | 0.25 | 1.01 | 2.01 | 1.3 |
| **48 Paper, Paperboard, Articles** | 15.78[b] | 3.00 | –6.35[a,w] | 0.94 | –0.009 | 0.18[b,i] | 0.19 | –0.05 | –0.12 | 0.42 | 0.39 | 4.02[b] | 4.91[a] | –0.58[a] | S | 2.18 | 0.01 | 6.69[b,as] | 7.48[a,as] |
| **49 Printed Books, Newspapers, Manusc.** | –20.14[c] | 10.40[a,i] | –4.86[b,w] | 1.52[c,i] | –0.12 | –0.27[b,w] | –0.27 | –0.07 | 0.08 | 0.46 | 0.008 | 1.36 | 3.88[b] | –0.53[a] | S | 0.57 | 4.82[b,as] | 1.49 | 1.78 |
| **56 Wadding, Felt, Yarn, Twine, Ropes** | 25.23[c] | 2.43 | –10.89[a,w] | –1.87[b,w] | –0.005 | 0.30[c,i] | –0.32 | –0.69[b,w] | –1.42 | 0.44 | 0.07 | 1.87 | 9.26[a] | –0.63[a] | S | 5.97[b,as] | 0.75 | 4.57[b,as] | 4.53[b,as] |
| **59 Impregnated, Text Fabrics** | 0.84 | –13.58 | 9.22 | –2.49 | –0.73[c,i] | –0.36 | 0.97 | 0.54 | –0.09 | 0.5 | 0.24 | 0.27 | 1.58 | –0.28 | S | 0.12 | 0.06 | 1.18 | 1.03 |
| **61 Apparel Articles, Accessories, Crochet** | –12.34 | 4.81 | 11.98 | 15.16[a,i] | –0.43 | –0.11 | –0.75 | –0.97 | –0.34 | 0.32 | 5.26[b] | 0.95 | 2.43 | –0.14 | S | 0.7 | 2.25 | 0.56 | 0.19 |
| **62 Apparel Articles** | –0.34 | 1.11 | 4.89 | 6.07[a,i] | 0.15 | –0.19 | –0.28 | 0.18 | 0.25 | 0.59 | 0.07 | 4.58[b] | 4.76[a] | –0.37 | S | 1.83 | 0.05 | 5.43[b,as] | 6.61[b,as] |

*(Table 2 continued)*

(Table 2 continued)

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^{-}_{US}$ | $TPU^{+}_{US}$ | $TPU^{-}_{JPN}$ | $TPU^{+}_{JPN}$ | $D_{Covid}$ | $\bar{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_JPN}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **63 Textile Art Nesoi, Needlecraft Sets** | –4.24 | 1.14 | –0.46 | –0.002 | 0.11 | 0.17[b,i] | –0.28[b,i] | –0.33[b,w] | –0.14 | 0.42 | 0.005 | 0.78 | 4.33[b] | –0.58[a] | S | 0.07 | 0.001 | 0.53 | 0.39 |
| **64 Footwear, Gaiters Etc. And Parts Thereof** | 45.35[c] | –8.63 | 1.75 | 2.98[c,i] | –0.14 | –0.13 | –0.004 | 0.03 | –0.61 | 0.4 | 0.58 | 0.89 | 1.96 | –0.36 | S | 0.72 | 0.11 | 0.004 | 0.01 |
| **65 Headgear and Parts Thereof** | 18.44[b] | 2.91 | –7.44[a,w] | 0.04 | 0.05 | 0.01 | 0.25[c,w] | 0.31[c,i] | 0.03 | 0.51 | 0.007 | 0.04 | 11.71[a] | –0.88[a] | S | 2.69 | 2.6 | 0.17 | 0.23 |
| **68 Art of Stone, Plaster, Cement, Mica** | 29.14[a] | –9.27[a,w] | 2.27 | 0.73 | –0.08 | –0.23[a,w] | 0.24 | 0.47[b,i] | 0.29 | 0.49 | 0.52 | 0.84 | 7.85[a] | –0.84[a] | S | 0.01 | 2.14 | 2.80[c,as] | 4.90[b,as] |
| **69 Ceramic Products** | –8.03 | –1.26 | –0.53 | –3.00[a,w] | 0.51[a,w] | 0.18[c,i] | –0.30[c,i] | 0.10 | 0.35 | 0.37 | 0.63 | 0.44 | 9.07[a] | –0.61[a] | S | 0.72 | 0.002 | 11.73[a,as] | 11.60[a,as] |
| **70 Glass, Glassware** | 2.63 | –0.76 | –0.25 | 0.67 | –0.17[c,i] | 0.0005 | 0.06 | –0.13 | –0.37 | 0.41 | 0.3 | 0.76 | 2.95 | –0.77 | S | 0.06 | 0.48 | 3.77[c,as] | 2.95[c,as] |
| **71 Nat Pearls, Prec Stones, Met, Coin** | –24.81[c] | –5.73 | 8.13[b,i] | –2.82[a,w] | 0.14 | 0.13 | –0.24 | –0.21 | –0.12 | 0.52 | 0.004 | 0.01 | 2.47 | –0.48 | S | 0.12 | 0.03 | 0.007 | 0.04 |
| **72 Iron and Steel** | –26.21 | –1.84 | 2.03 | –4.75[a,w] | 0.80[a,w] | 0.35 | –0.45 | 0.04 | 0.86 | 0.43 | 0.02 | 0.001 | 3.15 | –0.47[b] | S | 0.003 | 1.47 | 3.56[c,as] | 2.95[c,as] |
| **73 Articles of Iron/Steel** | –4.71 | 2.39 | –3.52 | –1.44 | –0.05 | –0.04 | –0.21 | –0.22 | 0.13 | 0.45 | 0.26 | 0.11 | 1.56 | –0.29 | S | 0.00002 | 0.43 | 0.009 | 0.001 |
| **74 Copper and Articles Thereof** | –16.13[a] | 4.31[b,i] | –3.39 | –1.88[a,w] | 0.10 | –0.13[b,w] | –0.10 | 0.16 | 0.48[c,i] | 0.46 | 0.06 | 5.54[b] | 11.27[a] | –0.89[a] | S | 1.13 | 0.26 | 15.28[a,as] | 14.08[a,as] |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **76 Aluminum and Articles Thereof** | –4.79 | 5.94 | $-4.76^{b,w}$ | 0.47 | –0.04 | –0.12 | $0.66^{b,w}$ | $0.70^{a,i}$ | 0.50 | 0.43 | 0.74 | 1.05 | $3.60^{c}$ | $-0.50^{b}$ | S | 1.34 | 0.002 | 0.42 | 0.11 |
| **82 Tools, Cutlery, Metal, Parts Thereof** | –8.07 | 0.37 | 0.44 | 0.22 | $-0.28^{a,i}$ | $-0.14^{c,w}$ | 0.11 | –0.04 | 0.03 | 0.36 | 1.38 | 0.61 | $4.07^{b}$ | $-0.68^{a}$ | S | 0.68 | 0.48 | $2.98^{c,as}$ | 2.47 |
| **83 Miscellaneous Articles of Base Metal** | 4.19 | 0.64 | –1.54 | $1.15^{a,i}$ | $0.13^{c,w}$ | $0.20^{a,i}$ | –0.06 | –0.12 | –0.07 | 0.47 | 0.3 | 2.55 | $13.54^{a}$ | $-0.85^{a}$ | S | 1.74 | 0.93 | 1.65 | 0.53 |
| **84 Nuclear Reactors, Boilers, Machinery** | $7.81^{b}$ | $-3.99^{a,w}$ | $1.34^{c,i}$ | –0.03 | –0.02 | 0.03 | 0.008 | –0.05 | –0.06 | 0.4 | 0.25 | $6.38^{b}$ | $3.95^{b}$ | $-0.49^{b}$ | S | 0.89 | 2.73 | 1.94 | 1.38 |
| **85 Electric Machinery, Sound Equip, Tv Eq.** | $-9.09^{a}$ | 0.81 | 0.30 | –0.21 | $-0.10^{a,i}$ | $-0.10^{a,w}$ | $0.13^{c,w}$ | $0.14^{b,i}$ | –0.06 | 0.56 | 1 | $12.15^{a}$ | $3.97^{b}$ | –0.96 | S | 0.001 | 0.17 | 0.01 | 0.03 |
| **86 Railway, Tramway, Traffic Signal Equip** | –17.48 | $14.85^{b,i}$ | $-10.22^{b,w}$ | 0.77 | 0.32 | $0.30^{c,i}$ | $0.59^{c,w}$ | 0.53 | $0.70^{c,i}$ | 0.44 | 1.78 | 0.75 | $4.46^{b}$ | $-0.42^{c}$ | S | 0.009 | 0.01 | 0.01 | 0.09 |
| **87 Vehicles, Except Railway or Tramway** | –3.61 | 4.55 | $-3.70^{c,w}$ | $1.37^{b,i}$ | –0.09 | 0.11 | 0.03 | –0.23 | –0.28 | 0.29 | 1.46 | $2.76^{c}$ | $5.17^{a}$ | $-0.42^{a}$ | S | 0.47 | 0.03 | $5.07^{b,as}$ | $5.75^{b,as}$ |
| **88 Aircraft, Spacecraft, Parts Thereof** | 2.37 | –4.55 | 3.05 | –0.12 | –0.04 | 0.19 | –0.07 | –0.33 | –0.14 | 0.34 | 0.7 | 1.18 | 2.78 | –0.38 | S | 0.06 | 0.004 | 1.75 | 1.57 |

*(Table 2 continued)*

(Table 2 continued)

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^-_{US}$ | $TPU^+_{US}$ | $TPU^-_{JPN}$ | $TPU^+_{JPN}$ | $D_{Covid}$ | $\bar{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_JPN}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **90 Optic, Medic, Surgical Instruments** | 1.31 | –2.94 | 2.95[c,i] | 0.96[c,i] | –0.11 | –0.13 | –0.0004 | 0.07 | 0.03 | 0.4 | 0.04 | 3.72[c] | 2.87 | –0.24 | S | 2.48 | 0.76 | 0.06 | 0.42 |
| **91 Clocks, Watches and Parts Thereof** | –1.96 | –1.24 | 1.47 | 0.83[a,i] | 0.03 | 0.06 | –0.08 | –0.10 | 0.21 | 0.45 | 1.05 | 0.008 | 9.23[a] | –1.01[a] | S | 1.62 | 5.99[b,as] | 0.6 | 0.05 |
| **92 Musical Instruments, Accessories Thereof** | –6.20 | 1.94 | –0.15 | 1.41[a,i] | –0.05 | –0.13[b,w] | –0.05 | 0.11 | 0.55[b,i] | 0.4 | 0.15 | 2.94[c] | 11.25[a] | –0.82[a] | S | 0.006 | 0.22 | 1.88 | 4.58[b,as] |
| **94 Furniture; Bedding Lamps Nesoi, Prefab** | –23.08 | 2.26 | –0.40 | –2.73[b,w] | 0.15 | 0.17 | 0.03 | –0.03 | 0.15 | 0.2 | 0.01 | 0.04 | 3.66[c] | –0.32[a] | S | 9.85[a,as] | 0.28 | 0.007 | 0.09 |
| **95 Toys, Games, Sport Equip., Accessories** | –32.74[a] | 3.32 | 2.06 | –1.17 | 0.008 | –0.37[a,w] | 0.84[b,w] | 1.31[a,i] | 0.64[b,i] | 0.45 | 1.16 | 1.24 | 4.17[b] | –0.46 | S | 2.12 | 6.04[b,as] | 6.55[b,as] | 7.34[a,as] |
| **96 Miscellaneous Manufactured Articles** | 6.32 | –8.36[b,w] | 4.39[c,i] | –1.20 | –0.20 | –0.002 | 0.19 | –0.01 | –0.39 | 0.38 | 0.3 | 2.21 | 4.58[b] | –0.46[a] | S | 0.16 | 1.15 | 2.55 | 1.77 |
| **97 Art, Collectors' Pieces and Antiques** | 65.16[c] | –9.80 | –9.24 | –4.82[b,w] | 0.19 | 0.40[c,i] | 0.10 | –0.20 | –0.32 | 0.45 | 0.05 | 1.67 | 2.85 | –0.53 | S | 0.11 | 0.64 | 0.62 | 0.83 |

**Table 3.** The Nonlinear ARDL Model Estimation Results (Normalised Long-run Coefficient for Total-export BTB: X).

| | Const. | $Y_{US}$ | $Y_{JPN}$ | *RER* | $TPU^{-}_{US}$ | $TPU^{+}_{US}$ | $TPU^{-}_{JPN}$ | $TPU^{+}_{JPN}$ | $D_{Covid}$ | $\bar{R}^2$ | *BG* | *RR* | $F_{PSS}$ | $ECT_{t-1}$ | *Cusum* | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_JPN}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **22 Beverages, Spirits and Vinegar** | –15.09[b] | 6.99[a,i] | –2.59[c,i] | 0.55 | 0.24 | 0.09 | –0.05 | 0.09 | 0.08 | 0.47 | 0.002 | 0.97 | 3.35[c] | –0.40 | S | 4.45[b,as] | 0.72 | 3.09[c,as] | 1.93 |
| **28 Inorg Chem, Radioact Compd** | 23.16[a] | –5.81[b,w] | 0.49 | –0.39 | –0.40[a,i] | –0.25[a,w] | –0.08 | –0.25[c,w] | –0.46[a,w] | 0.38 | 0.32 | 0.73 | 7.62[a] | –0.46[a] | S | 0.004 | 1.05 | 3.29[c,as] | 3.18[c,as] |
| **29 Organic Chemicals** | –5.47 | –1.69 | 2.82[c,i] | 0.03 | 0.16[b,w] | 0.10 | –0.16 | –0.06 | 0.03 | 0.5 | 0.34 | 0.0002 | 2.43 | –0.39 | S | 0.09 | 10.33[a,as] | 0.7 | 1.34 |
| **30 Pharmaceuti-cal Products** | –21.17[c] | 8.88[b,i] | –0.87 | 3.46[a,i] | –0.23[c,i] | –0.38[a,w] | –0.24 | –0.007 | –0.09 | 0.35 | 0.11 | 0.45 | 2.6 | –0.29 | S | 0.47 | 0.04 | 1.85 | 2.79[c,as] |
| **32 Tanning, Dye Ext, Paint, Putty, Inks** | –5.34 | –8.01[c,w] | 8.40 | –0.59 | 0.008 | –0.19 | 0.04 | 0.30 | 0.12 | 0.57 | 1.24 | 0.04 | 4.35[b] | –0.30 | S | 2.58 | 8.50[a,as] | 2.09 | 2.3 |
| **33 Essential Oils, Perfumery, Cosmetic** | 0.58 | 2.02[c,i] | –1.30[b,w] | 0.44[c,i] | –0.04 | –0.07[c,w] | 0.03 | 0.03 | 0.17 | 0.52 | 0.37 | 0.46 | 2.86 | –0.75[c] | S | 2.54 | 1.22 | 0.46 | 0.02 |
| **35 Albuminoidal Subst, Glue, Enzymes** | 7.20[b] | –1.44 | 0.07 | 0.23 | –0.01 | 0.04 | –0.10[c,i] | –0.16[a,w] | –0.14 | 0.46 | 0.25 | 0.25 | 10.26[a] | –0.76[a] | S | 0.04 | 5.59[b,as] | 2.51 | 2.17 |
| **37 Photographic or Cinematog. Goods** | 9.91 | –1.76 | –1.06 | –0.13 | 0.010 | 0.14[c,i] | –0.20 | –0.36[b,w] | –0.14 | 0.39 | 0.02 | 0.3 | 2.84 | –0.33 | S | 3.08[c,as] | 0.91 | 2.46 | 2.67 |

*(Table 3 continued)*

(Table 3 continued)

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU^-_{US}$ | $TPU^+_{US}$ | $TPU^-_{JPN}$ | $TPU^+_{JPN}$ | $D_{Covid}$ | $\bar{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_JPN}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **38 Miscellaneous Chemical Products** | –0.03 | –0.48 | 0.26 | –0.22 | 0.04 | –0.04[c,w] | –0.04 | 0.05 | –0.11 | 0.48 | 0.15 | 3.28[c] | 8.63[a] | –0.77[a] | S | 2.3 | 1.49 | 12.37[a,as] | 12.50[a,as] |
| **39 Plastics and Articles Thereof** | 5.54 | –4.6[c,w] | 3.46[c,i] | 0.20 | –0.03 | 0.002 | –0.10 | –0.13 | –0.05 | 0.53 | 0.01 | 0.66 | 3.02 | –0.22 | S | 0.001 | 0.89 | 0.42 | 0.17 |
| **40 Rubber and Articles Thereof** | –10.75[a] | –0.20 | 1.67[a,i] | –0.43[a,w] | 0.13[a,w] | 0.09[a,i] | –0.009 | 0.04 | 0.24[b,i] | 0.46 | 0.12 | 0.09 | 7.25[a] | –0.95[a] | S | 6.94[a,as] | 0.75 | 4.09[b,as] | 3.18[c,as] |
| **42 Leather Art, Handbags, Gut Art** | 11.77[c] | 4.78[a,i] | –5.59[a,w] | 1.04[b,i] | –0.08 | –0.15[a,w] | 0.08 | 0.14 | –0.29[c,w] | 0.49 | 0.01 | 0.12 | 5.30[a] | –0.57[a] | S | 0.19 | 0.42 | 1.62 | 1.15 |
| **44 Wood, Articles' Wood** | –16.01 | 4.34[c,i] | 0.72 | 0.43 | –0.09 | –0.37[a,w] | 0.25 | 0.57[a,i] | 0.04 | 0.41 | 0.4 | 0.36 | 3.36[c] | –0.41[b] | S | 1.78 | 3.02[c,as] | 12.03[a,as] | 10.76[a,as] |
| **48 Paper, Paperboard, Articles** | 11.66[b] | –1.44 | –0.94 | 0.21 | –0.25[b,i] | –0.09[c,w] | 0.50[b,w] | 0.30[b,i] | 0.05 | 0.57 | 1.35 | 0.88 | 4.11[b] | –0.43 | S | 10.57[a,as] | 14.77[a,as] | 2.74[c,as] | 2.54 |
| **49 Printed Books, Newspapers, Manusc.** | 11.03[b] | 4.99[a,i] | –5.61[a,w] | 1.49[a,i] | 0.21[a,w] | 0.20[a,i] | –0.18[c,i] | –0.17[c,w] | –0.25[c,w] | 0.6 | 0.05 | 0.34 | 5.56[a] | –0.76[c] | S | 1.08 | 0.01 | 0.15 | 0.1 |
| **56 Wadding, Felt, Yarn, Twine, Ropes** | 13.26 | –3.77 | 1.85 | 1.08[b,i] | 0.01 | –0.07 | 0.0007 | 0.11 | –0.03 | 0.48 | 0.09 | 2.34 | 2.77 | –0.43 | S | 0.06 | 0.45 | 1.15 | 1.11 |
| **59 Impregnated, Text Fabrics** | –7.89[a] | 2.64[b,i] | –1.99[a,w] | –0.90[a,w] | 0.02 | 0.003 | –0.06 | –0.05 | –0.19 | 0.47 | 1.3 | 3.58[c] | 5.25[a] | –0.88[a] | S | 0.01 | 0.42 | 0.31 | 0.03 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **61 Apparel Articles, Accessories, Crochet** | 30.02 | –4.03 | 8.43 | 11.54[a,i] | –0.35 | 0.10 | –0.85 | –1.28 | –0.45[c,w] | 0.3 | 4.29[b] | 2.14 | 2.35 | –0.12 | S | 1.18 | 1.77 | 1.01 | 0.65 |
| **62 Apparel Articles** | –6.63 | 0.81 | 5.14 | 4.08[a,w] | 0.21 | –0.17 | –0.29 | 0.19 | 0.24 | 0.62 | 0.13 | 5.91[b] | 3.70[c] | –0.27 | S | 0.79 | 0.77 | 3.51[c,as] | 3.65[c,as] |
| **63 Textile Art Nesoi, Needlecraft Sets** | 5.38 | 0.40 | –1.41 | 0.10 | –0.09 | 0.17[c,i] | –0.10 | –0.41[b,w] | –0.42[a,w] | 0.42 | 3.07[c] | 0.01 | 4.18[b] | –0.39[b] | S | 0.22 | 0.34 | 7.91[a,as] | 8.11[a,as] |
| **64 Footwear, Gaiters Etc. And Parts Thereof** | 18.03 | –0.37 | –0.03 | 2.96[a,i] | –0.02 | –0.09 | –0.26 | –0.15 | –0.60[c,w] | 0.4 | 0.0002 | 0.83 | 4.28[b] | –0.52[a] | S | 1.6 | 0.97 | 0.27 | 0.46 |
| **65 Headgear and Parts Thereof** | 4.32 | 3.47 | –4.66[c,w] | –0.16 | 0.04 | 0.0007 | –0.03 | 0.006 | –0.26 | 0.52 | 0.67 | 0.08 | 2.47 | –0.65 | S | 0.16 | 1.9 | 0.16 | 0.13 |
| **68 Art of Stone, Plaster, Cement, Mica** | –1.53 | 0.23 | 0.11 | 0.28 | –0.17[a,i] | –0.08[b,w] | 0.16[b,w] | 0.06 | –0.24[c,w] | 0.37 | 0.33 | 0.35 | 10.68[a] | –0.75[a] | S | 5.85[b,as] | 0.5 | 6.04[b,as] | 6.03[b,as] |
| **69 Ceramic Products** | 19.42[b] | –7.10[b,w] | 2.93 | 0.55 | –0.17 | –0.08 | 0.11 | 0.02 | –0.27 | 0.44 | 1.87 | 0.4 | 1.92 | –0.48 | S | 0.01 | 0.27 | 1.08 | 0.73 |
| **70 Glass, Glassware** | –17.65 | 3.09 | 0.03 | –0.88 | 0.26 | 0.19 | –0.19 | –0.11 | 0.06 | 0.38 | 0.27 | 0.35 | 2.07 | –0.17 | S | 3.01[c,as] | 0.05 | 0.28 | 0.25 |
| **71 Nat Pearls, Prec Stones, Met, Coin** | –3.42 | –1.04 | 0.55 | –1.50[a,w] | 0.17[c,w] | 0.29[a,i] | –0.38[b,i] | –0.52[a,w] | –0.49[b,w] | 0.4 | 1.06 | 0.28 | 8.26[a] | –0.61[a] | S | 2.1 | 0.25 | 2.51 | 2.27 |
| **72 Iron and Steel** | 13.80 | –13.74[c,w] | 8.62[c,i] | –1.20 | –0.49 | –0.29 | 0.42 | 0.20 | –0.12 | 0.42 | 1.1 | 1.16 | 1.92 | –0.19 | S | 5.37[b,as] | 0.18 | 0.82 | 0.72 |
| **73 Articles of Iron or Steel** | –0.27 | –2.56[a,w] | 0.66 | –1.52[a,w] | 0.03 | 0.07[a,i] | –0.002 | –0.04 | 0.04 | 0.56 | 0.41 | 2.29 | 5.97[a] | –0.89[a] | S | 0.86 | 1.09 | 2.89[c,as] | 2.42 |

*(Table 3 continued)*

(Table 3 continued)

| | Const. | $Y_{US}$ | $Y_{JPN}$ | $RER$ | $TPU_{US}^{-}$ | $TPU_{US}^{+}$ | $TPU_{JPN}^{-}$ | $TPU_{JPN}^{+}$ | $D_{Covid}$ | $\bar{R}^2$ | $BG$ | $RR$ | $F_{PSS}$ | $ECT_{t-1}$ | Cusum | $W_{SR}^{TPU\_US}$ | $W_{SR}^{TPU\_JPN}$ | $W_{LR}^{TPU\_US}$ | $W_{LR}^{TPU\_JPN}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **74 Copper and Articles Thereof** | 6.11 | –1.02 | 1.33 | 1.90$^{a,i}$ | 0.004 | 0.006 | –0.48$^{b,i}$ | –0.45$^{b,w}$ | 0.01 | 0.42 | 0.03 | 0.004 | 3.53$^{c}$ | –0.36$^{c}$ | S | 1.4 | 0.14 | 0.001 | 0.1 |
| **76 Aluminum and Articles Thereof** | 7.49 | 1.30 | –2.30 | 0.83 | –0.15 | 0.08 | 0.009 | –0.28 | –0.26$^{b,w}$ | 0.37 | 1.28 | 2.22 | 1.12 | –0.14 | S | 2.93$^{c,as}$ | 1.11 | 1.73 | 1.65 |
| **82 Tools, Cutlery, Metal, Parts Thereof** | –0.05 | –1.46 | 0.91 | –0.04 | –0.16$^{a,i}$ | –0.09$^{b,w}$ | 0.03 | –0.05 | –0.20 | 0.28 | 0.04 | 1.48 | 10.98$^{a}$ | –0.67$^{a}$ | S | 2.36 | 0.84 | 2.76$^{c,a}$s | 2.59 |
| **83 Miscellaneous Articles of Base Metal** | –13.98 | 3.56 | –1.23 | –0.49 | –0.01 | –0.09 | –0.22 | –0.12 | –0.09 | 0.21 | 0.23 | 0.08 | 1.5 | –0.20 | S | 2.42 | 0.05 | 0.35 | 0.41 |
| **84 Nuclear Reactors, Boilers, Machinery** | 1.35 | –3.12$^{a,w}$ | 1.09$^{b,i}$ | –1.44$^{a,w}$ | 0.08$^{a,w}$ | 0.02 | –0.06$^{c,i}$ | 0.004 | 0.07 | 0.52 | 0.38 | 2.69 | 5.47$^{a}$ | –0.60$^{a}$ | S | 0.07 | 0.07 | 7.06$^{a,as}$ | 6.77$^{b,as}$ |
| **85 Electric Machinery, Sound Equip, Tv Eq.** | –9.86$^{a}$ | 3.74$^{b,i}$ | –2.17$^{b,w}$ | –0.46$^{b,w}$ | 0.07 | –0.03 | –0.01 | 0.10 | –0.001 | 0.63 | 0.05 | 1.46 | 3.57$^{c}$ | –0.47 | S | 0.35 | 0.08 | 7.60$^{a,as}$ | 6.46$^{b,as}$ |
| **86 Railway, Tramway, Traffic Signal Equip** | 17.54 | 2.50 | –5.87$^{b,w}$ | 0.70 | 0.17 | 0.48$^{a,i}$ | 0.28 | –0.13 | 0.09 | 0.41 | 1.06 | 4.32$^{b}$ | 4.55$^{b}$ | –0.48$^{b}$ | S | 1.38 | 1.04 | 6.80$^{a,as}$ | 8.26$^{a,as}$ |
| **87 Vehicles, Except Railway or Tramway** | –3.76 | 1.22 | –0.67 | 0.36 | 0.06 | 0.04 | –0.003 | 0.02 | 0.14 | 0.5 | 0.005 | 0.91 | 5.62$^{a}$ | –0.59$^{a}$ | S | 1.89 | 4.10$^{b,as}$ | 0.52 | 0.29 |
| **88 Aircraft, Spacecraft, Parts Thereof** | 4.30 | –1.96 | 1.03 | –0.32 | 0.05 | 0.13$^{b,i}$ | 0.16 | 0.02 | 0.35 | 0.44 | 0.28 | 0.82 | 6.42$^{a}$ | –0.78$^{a}$ | S | 0.03 | 0.48 | 2.06 | 3.84$^{c,as}$ |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **90 Optic, Medic, Surgical Instruments** | 2.73 | −2.97 | 3.11[c,i] | 0.89[b,i] | −0.009 | −0.007 | 0.01 | 0.03 | 0.01 | 0.59 | 1.13 | 2.25 | 2.93 | −0.23 | S | 3.25[c,as] | 0.04 | 0.02 | 0.13 |
| **91 Clocks, Watches and Parts Thereof** | 7.33 | −11.58[a,w] | 9.76[a,i] | 0.84 | −0.03 | −0.11[c,w] | −0.22[c,i] | −0.06 | 0.03 | 0.46 | 1.42 | 0.001 | 4.72[a] | −0.55[c] | S | 2.06 | 0.16 | 1.43 | 3.57[c,as] |
| **92 Musical Instruments, Accessories Thereof** | −13.51[a] | 3.20[b,i] | 0.51 | 0.98[b,i] | −0.11[b,i] | −0.18[a,w] | 0.01 | 0.12[c,i] | 0.15 | 0.46 | 0.33 | 4.76[b] | 4.28[b] | −0.61 | S | 1.58 | 0.03 | 2.81[c,as] | 5.17[b,as] |
| **94 Furniture; Bedding Lamps Nesoi, Prefab** | −2.87 | 2.04 | −2.14 | −1.09[c,w] | 0.16 | −0.02 | 0.19 | 0.37[b,i] | 0.19 | 0.3 | 2.27 | 0.65 | 2.62 | −0.27 | S | 0.02 | 0.8 | 4.22[b,as] | 2.87[c,as] |
| **95 Toys, Games, Sport Equip., Accessories** | −25.80[b] | 12.45[a,i] | −7.86[b,w] | −1.28 | 0.18 | −0.08 | 0.13 | 0.43 | 0.03 | 0.32 | 1.34 | 0.49 | 2.75 | −0.35 | S | 1.39 | 1.14 | 3.61[c,as] | 3.34[c,as] |
| **96 Miscellan-eous Manufactured Articles** | −9.28[a] | 1.81[c,i] | −0.30 | −0.07 | 0.02 | 0.04 | −0.05 | −0.08 | −0.09 | 0.49 | 1.25 | 3.41[c] | 13.94[a] | −1.02[a] | S | 0.88 | 0.45 | 0.54 | 0.95 |
| **97 Art, Collectors' Pieces and Antiques** | 18.89[b] | −11.27[a,w] | 4.03[c,i] | −3.14[a,w] | 0.12 | 0.16[c,i] | 0.17 | 0.11 | 0.76 | 0.53 | 7.13[a] | 1.59 | 2.89 | −1.05 | S | 4.45[b,as] | 0.72 | 3.09[c,as] | 1.93 |

**Notes:** *a*, *b* and *c* show the significance at the 1%, 5% and 10%, respectively. *w* and *i* indicate that related independent variable 'worsens' and 'improves' bilateral trade balances of the USA with Japan for the related goods. BG: Breusch-Godfrey Serial Correlation LM test and its critical value at 1%, 5% and 10% level is 6.63, 3.84 and 2.71. $W_{SR}$ and $W_{LR}$ are short-run and long-run Wald test, respectively. *as*; Denotes asymmetry. *RR*; Ramsey-RESET model misspecification test, $F_{PSS}$; *F* cointegration test of Pesaran et al. (2001), $ECT_{t-1}$; Error correction term. S; Stable.

*BTB, non-production-related BTB and total-export BTB*, respectively. Additionally, we present a summary Table 4 (derived from Tables 1–3) that clearly shows whether changes in independent variables worsen or improve BTBs above, separately. The letters '*w*' and '*i*', in Tables 1–3. Furthermore, worsening and improvement numbers in Table 4 and their code numbers in Table 5 are only the BTBs of the industries that have long run cointegration by either the *F* test of Pesaran et al. (2001) or *ECT* test. We report the model estimations and diagnostic test results in the following tables only for the long-run since this study is a long-run analysis.

Before examining the impacts of independent variables on different forms of US BTBs with Japan, we re-explain the definitions of the abbreviations used in Tables 1–5 and the paragraphs below for easy reading. $X^p$: *production-related BTB* (*based on US domestic goods*), $X^{np}$: *non-production-related BTB* (*based on US re-eorted goods*), and $X$: *total-export BTB (based on US total export).* Test results in the tables above clearly reveal that a bilateral trade model of the USA with Japan should be constructed and analysed on the proposed forms of BTBs separately rather than a traditional BTB, constructed on total export/total import. Because the impacts of independent variables on *production-related BTB* ($X^p$), *non-production-related BTB* ($X^{np}$) and *total-export BTB* ($X$) are entirely different. For example, while a rise in Japan's TPU index ($TPU^{+}_{JPN}$) worsens the US *production-related BTB* for six industries, the same rise worsens the US *non-production-related BTB* only for two industries. This means that the worsening impact of Japan's increasing TPU is less on the *non-production-related BTB* than on the *production-related BTB*. This may be interpreted to mean that Japanese consumers, under rising uncertainty in Japan, purchase (import) more re-exported goods ($X^{np}$) from the USA than domestic goods ($X^p$) produced/processed within the USA. This may be due to the fact that the USA imports from abroad for consumption purposes but cannot consume and re-exports to Japan at below world prices.

However, while a fall in Japan's TPU index ($TPU^{-}_{JPN}$) worsens the *production-related BTB* only for three industries, the same fall worsens the *non-production-related BTB* for seven industries. This can also be interpreted to mean that Japanese consumers, under falling uncertainty in Japan, purchase (import) fewer re-exported goods ($X^{np}$) than US domestic goods ($X^p$). This may stem from the markups on imported goods (due to potential duties, taxes and storage costs), and, thereby, fewer US re-exports to Japan. Hence, we may conclude that Japanese consumers, under falling uncertainty in Japan, are more sensitive to US exported goods ($X^{np}$) than domestic goods ($X^p$).

On the other hand, rises and falls in total in the US TPU index have more impacts on $X^p$ and $X^{np}$ than the impacts of rises and falls of Japan's TPU index. This may stem from the fact that the US economy is much larger than Japan's; thereby, US imports from Japan are more than Japan's imports from the USA. Therefore, changes in TPU in the USA play a more determining role than changes in Japan on bilateral trade volumes between two countries. This result can also be explained from the Japanese consumers' side only since Hofstede (1980) states that the Japanese are one of the highest uncertainty avoidance people.

**Table 4.** *Total Numbers of Improvement and Worsening Impacts on BTBs and Industry Codes.*

| | $Y_{US}$ | | | $Y_{JPN}$ | | | $RER_{YEN-USD}$ | | | $TPU^-_{US}$ | | | $TPU^+_{US}$ | | | $TPU^-_{JPN}$ | | | $TPU^+_{JPN}$ | | | $D_{Covid}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ |
| Worsen | 6 | 4 | 5 | 5 | 9 | 6 | 6 | 7 | 7 | 6 | 4 | 4 | 7 | 10 | 10 | 3 | 7 | 2 | 6 | 2 | 6 | 8 | 1 | 7 |
| Improve | 6 | 6 | 9 | 6 | 5 | 4 | 8 | 9 | 6 | 5 | 2 | 5 | 7 | 6 | 7 | 5 | 2 | 6 | 3 | 8 | 3 | 5 | 6 | 1 |

**Notes:** BTB: Bilateral Trade Balance. $X^p$: *Production-related BTB (based on the US domestic goods)*. $X^{np}$: *Non-production-related BTB (based on the US re-exported goods)*. X: *Total-export BTB (based on the US total export). RER denotes depreciation in USD.*

**Table 5.** Industry Codes.

| | $Y_{US}$ | | | $Y_{JPN}$ | | | $RER$ | | | $TPU^-_{US}$ | | | $TPU^+_{US}$ | | | $TPU^-_{JPN}$ | | | $TPU^+_{JPN}$ | | | $Covid$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ | $X^p$ | $X^{np}$ | $X$ |
| Worsens | 28; 39; 73; 84; 91; 97 | 38; 68; 84; 96 | 28; 32; 73; 84; 91 | 33; 42; 49; 59; 85 | 37; 42; 48; 49; 56; 65; 76; 86; 87 | 33; 42; 49; 59; 85; 86 | 40; 59; 73; 84; 85; 97 | 22; 38; 56; 69; 72; 74; 94 | 40; 59; 62; 71; 73; 84; 85 | 40; 49; 73; 84; 85; 97 | 22; 69; 72; 83 | 40; 49; 71; 84 | 28; 38; 44; 48; 68; 82; 92 | 30; 42; 44; 49; 68; 74; 82; 85; 92; 95 | 28; 33; 38; 42; 44; 48; 68; 82; 91; 92 | 48; 68; 88 | 39; 42; 65; 76; 85; 86; 95 | 48; 68 | 28; 35; 63; 74; 91; 96 | 56; 63 | 28; 35; 49; 63; 71; 74; | 28; 42; 49; 61; 63; 64; 82; 91 | 38 | 28; 42; 49; 63; 64; 68; 71 |
| Improves | 33; 49; 59; 85; 92; 96 | 30; 37; 42; 49; 74; 86 | 22; 33; 42; 44; 49; 59; 85; 92; 96 | 39; 40; 73; 84; 91; 97 | 28; 29; 38; 84; 96 | 22; 40; 84; 91 | 33; 42; 49; 61; 64; 74; 91; 92 | 30; 35; 42; 49; 62; 83; 87; 91; 92 | 33; 42; 49; 64; 74; 92 | 28; 48; 68; 82; 92 | 82; 85 | 28; 48; 68; 82; 92 | 40; 49; 73; 84; 88; 96; 97 | 48; 56; 63; 69; 83; 86 | 40; 49; 63; 71; 73; 86; 88 | 35; 74; 84; 91; 96 | 63; 69 | 35; 49; 71; 74; 84; 91 | 44; 48; 92 | 22; 28; 42; 65; 68; 76; 85; 95 | 44; 48; 92 | 40; 84; 87; 88; 97 | 28; 29; 74; 86; 92; 95 | 40 |

Furthermore, Japanese consumers purchase (import) fewer re-exported goods ($X^{np}$) from the USA than US domestic goods ($X^{p}$) when their income rises (nine and five). Regarding the impact of the exchange rate, the improvement impact of real depreciated USD on $X^{p}$ and $X^{np}$ is more than its worsening impact. Japanese consumers with stronger YEN purchase (import) slightly more US re-exported goods ($X^{np}$) than US domestic product goods ($X^{p}$). Lastly, test results in the tables above indicate that the worsening impact of the COVID-19 pandemic on US domestic product goods ($X^{p}$) is much higher than on re-exported goods ($X^{np}$). This can be interpreted to mean that the COVID-19 pandemic negatively affects US domestic goods more than re-exported goods. If we relied only on traditional trade balance ($X$), we would not see that the COVID-19 pandemic improved *production-related BTB* for five industries and *non-production-related BTB* for six industries.

Additionally, Table 5 reports the BTBs based on industries (with their codes) and how they are affected (improved or worsened) by changes in both countries exchange rates, incomes and TPU indexes. For instance, a rise in Japan's TPU index ( $TPU^{+}_{JPN}$ ) improves the *non-production-related BTBs* ($X^{np}$) of the industries in the shaded cell.

## Conclusion

This study's main aim is to reveal the need to analyse BTB models with new forms of BTBs for two reasons. The first reason is that the traditional form of BTB, based on a total export/total import ratio, assumes that countries export only their domestic goods produced within their countries (denotes domestic export). However, countries also export some goods already imported from other countries (denotes re-export). Therefore, we should redefine and reformulate new forms of BTBs constructed on domestic goods and re-exported goods separately to achieve more accurate results. In this context, we, for the first time, attempted to reformulate two new forms of BTBs as *the production-related BTB and non-production-related BTB*. The second reason is that the economic impacts of these two new forms of BTBs will be in different magnitudes because, while *the* production-*related BTB* undergoes a value-added process in a country (domestic export), *the non-production-related BTB* does not (re-exported). Therefore, the methodology proposed in this study will enable policymakers to examine BTBs of countries based on economic impact contents. Hence, the USA seems to be a unique sample country requiring this methodological analysis since the country re-exports to Japan and collects its export data separately, as domestic export and re-export. Although many countries re-export, they cannot/do not collect such data separately. The main empirical finding supports the need to redefine/reformulate US BTBs since the impacts of income, real exchange rate, TPU, and the COVID-19 pandemic on these two new forms of BTBs are entirely different. We strongly believe that the future new forms of BTBs, defined on the basis of different related macroeconomic variables, will enable policymakers to implement more sustainable and manageable trade policies at a lower cost. Today, hundreds of countries have been experiencing large trade deficits. However, with the methodology proposed in this study, these countries will, to some degree, be able to identify what kind of deficits they have, rather than knowing their trade deficit volumes only as single values. What it means for these countries is that a trade deficit in domestic goods will be economically more crucial than a trade deficit in re-exported goods.


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## Authors' Contribution

Dr Ismet Gocer and Dr Serdar Ongan chosen set the subject and theoretical background of it. Dr Serdar Ongan wrote the Introduction, Dr Ismet Gocer wrote the econometric methodology. Dr Huseyin Karamelikli did econometric analyses. Dr Ismet Gocer reported results. Dr Ismet Gocer and Dr Serdar Ongan interpreted findings. Dr Charles A. Rarick wrote policy implications.

## Data Availability Statement

No special/confidential data set was used during the preparation of this study. The sources from which the data used are taken are specified in the relevant sections of the study and the details are presented in the references section.

## Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

## Ethical Consent

During the preparation of this study, scientific ethical rules were meticulously followed.


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# Appendix

The technical construction of the TPU index:

The TPU index,[3] as a news-based index, is constructed on the frequency of articles on leading US[4] and Japanese[5] newspapers. It counts some terms which may reflect the uncertainties in trade policies such as *import tariffs, import duty, import barrier, government subsidies, government subsidy, WTO, World Trade Organization, trade treaty, trade agreement, trade policy, trade act, Doha round, Uruguay round, GATT, dumping, Federal Reserve, legislation and White House.* The construction of this index can be presented in the following summary steps and formulas (Baker et al., 2016; Čižmešija et al., 2017; Davis et al., 2019):

1. Counting the (aforementioned) words and get the series of scaled TPU frequency ($X_{it}$) for a newspaper $i = 1, 2, ..., N$ in month $t$. $N$ is a number of newspapers.
2. Calculating the times-series variance ($\sigma_{it}$) of $X_{it}$ for the interval from the first to the last year for each newspaper.
3. Getting the relative frequencies with $Y_{it} = \frac{X_{it}}{\sigma_i}$ and dividing them by the number of newspapers ($N$) to get the averages $Z_t = \frac{1}{\boldsymbol{N}} \sum_{i=1}^{N} Y_{it}$.
4. Finally, calculating the mean ($M$) of $Z_t$ in the interval, multiply $Z_t$ by (100/$M$) for all $t$ as ($TPU_t = \frac{Z_t}{M} * 100$) and get the normalised TPU time-series index.

## Notes

1. Domestic Exports – Goods grown, produced or manufactured in the United States and goods of foreign origin that have been changed, enhanced in value, or improved in condition by further processing or manufacturing in the United States (ITA, 2021).
2. Re-exports – Previously imported goods that were grown, produced, or manufactured in a foreign country and which, at the time of export, have not undergone substantial transformation in form or condition, which adds a significant amount or percentage of value in comparison to its untransformed value) in the United States (ITA, 2021).
3. For further detailed information, visit https://www.policyuncertainty.com/methodology.html
4. *The USA Today*, *Miami Herald*, *Chicago Tribune*, *Washington Post*, *Los Angeles Times*, *Boston Globe*, *San Francisco Chronicle*, *Dallas Morning News*, *New York Times* and *Wall Street*.
5. *Yomiuri*, *Asahi*, *Mainichi* and *Nikkei*.

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