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4 November 2020

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Abstract

The study of the services trade balance dynamics following depreciation is a novel topic in international finance literature, with limited empirical research conducted (principally in the US context). This paper examines the relationship between the real exchange rate and the services trade balance in the UK using the quarterly data for the 2005Q1 - 2019Q4 period. We consider the aggregate as well as disaggregated trade across five services categories and employ linear and non-linear autoregressive distributed lag (ARDL) models. The findings indicate little evidence of a long-term improvement in the trade balance following depreciation, and suggest the absence of J-curve effect. The effects of domestic, 'rest of the world' GDP and monetary base on the trade balance were respectively negative, positive, and mixed.

Keywords: J-curve; cointegration; ARDL; services

JEL Code: F14, F31, C22

Introduction

The growing importance of services sector in the industrialised countries has been well explored in theoretical and empirical research (Chenery, 1960; Pasinetti, 1993). The services economy has been examined from different angles: the origins and determinants of services growth; the implications of services economy for productivity, profitability and employment; innovation in the services sector; the interrelationship between services and foreign investment; among other issues (Baumol, et al, 1985; Barras, 1986; Tether, 2003; Doytch, Uctum, 2011). As far as services and international trade link is concerned, the conventional view has been that services are nontradeables, resulting in the lack of testing of hypotheses that were in contrast tested extensively in the manufacturing trade context. Specifically, regarding the J-curve hypothesis (that can be summarised as deterioration of the trade balance in the short-term following depreciation/devaluation and subsequent improvement of the balance in the long-term), the number of studies that attempted to validate J-curve effect in the services trade was somewhat limited (Yazici, 2010; Prakash, Maiti, 2016; Cheng, 2020). The present paper attempts to address this gap, by examining the possibility of J-curve in the UK services trade with the rest of the world at aggregate and disaggregated level.

Such examination is warranted, given that as of 2018 the services constituted 46% of UK exports, a high figure in comparison to services exports in other developed economies (Jozepa et al, 2019: 8).[1] A notable feature of UK services trade is its absolute value (the value of services exports and imports of 297 billion and 193 billion of pound sterling respectively in 2018), the prominent position of the UK internationally as the second largest exporter of services in the world and prime player in finance, insurance, air and sea transport, and higher education, as well as the scale of diversification of services trade, both in terms of the number of sub-sectors and export and import destinations (albeit professional and business services constitute roughly one third of total exports or imports of services).

The paper examines the presence of J-curve in the aggregate services trade of the UK, as well as in the following services sub-sectors: transportation, travel, goods-related, commercial, and other services.
The preferred approach in the analysis of J-curve is the use of higher frequency data (e.g. quarterly), consideration of disaggregated trade (up to the level of specific commodity/product traded) and focus

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[1] The share of services in the UK total imports, however, is comparable to other developed economies (Jozepa et al, 2019: 13).

on the bilateral trade between the selected countries (as opposed to the trade of the country in question with the rest of the world). The data limitations typically prevent from achieving these, as is the case in the present paper. We use quarterly data stretching 2005Q1-2019Q4 period, consider trade in disaggregated services, but do not examine bilateral trade of the UK. The application of linear an non-linear ARDL is warranted for the following reasons. Firstly, the use of data with unit roots in the OLS model (an approach commonly taken in the early empirical studies of the J-curve) likely leads to spurious results. However, in contrast to Johansen-Juselius cointegration approach, ARDL does not require that all variables considered have unit roots in levels but not in the first differences, and instead allows for a mixed order of integration. Secondly, ARDL obviates the problems of fixed lag structure and the ordering of the variables that are typical to VAR/VECM system specification and instead models the relationships in a single equation. Thirdly, it tends to yield more consistent results in small samples.

The structure of the paper is as follows. Section 2 provides a brief survey of the existing literature on the J-curve effect in aggregate and the services trade. Section 3 describes the model, the data and econometric methodology. Section 4 presents the empirical results, while Section 5 contains the concluding remarks.

Literature review

The premise of J-curve hypothesis is that depreciation (devaluation) of the domestic currency will produce deterioration of the domestic trade balance immediately after the event, followed by its improvement further down the track. However, other reactions of the trade balance to devaluation (depreciation) may be encountered: Magee (1973) mentions the plausibility of I-, L-, M-, N-, V- and W-curves, conditional on the values of the price elasticities of domestic and foreign demand for imports and supply of exports, and currencies (domestic or foreign) in which contracts are written.

While the long-run response of the trade balance to depreciation is positive, provided that the sum of the price elasticities of domestic and foreign demand for imports exceeds one, and both price elasticities of domestic and foreign supply of exports are infinite (Marshall-Lerner condition), the adjustments to depreciation in the short-run are more complex. Specifically, the J-curve effect involves the distinction between currency-contract, pass-through and quantity adjustment stages. Assume that trade balance takes the following general form:

$$TB = P_x X - E P_x^* M \tag{1}$$

,where E is a nominal exchange rate, P_x and P_x^* are domestic and foreign export prices (respectively in domestic and foreign currencies), and X and M are export and import volumes.

At the currency-contract stage, the contracts signed prior to depreciation fall due after it: the exchange rate E alters trade balance, while X and M remain unchanged. The deterioration of the trade balance at this stage premised by the J-curve effect takes place if export (import) contracts of the country are nominated in domestic (foreign) currency. At the pass-through stage, the substitution between imported and domestically produced goods (in both trading economies) starts to take momentum, “to the extent that the prices of foreign goods change in terms of their domestic currency following a devaluation” (Magee, 1973: 315). The substitution is not complete at this stage, since the adjustment in export and import volumes is lagging (inelastic export supply and/or import demand prevent domestic exporters altering their sales overseas and domestic importers finding adequate substitutes to imported goods fast enough). At the pass-through stage, the trade balance deteriorates in the case of low price elasticity of demand for domestic imports and exports, and improves in the case of low price elasticity of supply for domestic imports and exports. At the quantity adjustment stage, the price elasticities of exports and imports increase compared to the previous stages. As a result, X rises and M falls faster than respective prices fall (rise), thereby improving trade balance.

The empirical literature on J-curve effect and Marshall-Lerner condition has been voluminous, covering a large number of economies, applying a variety of econometric methods, and considering several aspects of the problem. In the review that follows we consider only a selected number of works and classify them on a geographical and methodological basis.

The empirical research has been conducted for a number of individual economies, including USA (Demirden, Pastine, 1995), Australia (Flemingham, 1988), Japan (Guptar-Kapoor, Ramakrishnan, 1999), Singapore (Bahmani-Oskooee, Harvey, 2017), Pakistan (Bahmani-Oskooee et al, 2017), Argentina and Brazil (Costamagna, 2014), Turkey (Akbostanci, 2004) to name a few. The multi-country studies included Arize, 1987 (African nations), Hsing, 2010 (East Asian economies), among others.

The empirical studies differed in a range of methodological aspects. Firstly, concerning the scope of the trade, the empirical research examined the aggregate trade of the country with the rest of the world (Flemingham, 1988; Lal, Lowinger, 2002; Prikh, Shibata, 2004; Senhadji, 1998); the disaggregated trade of the country with the rest of the world, either the trade in broader sectors, such as services, agriculture or manufactured goods' trade or in specific products/commodities in the standard international trade classification (SITC) of goods (Prakash, Maiti, 2016); as well as bilateral trade between the countries, typically at a disaggregated level (Bahmani-Oskooee, Ratha, 2004b). The consensual view has been that the latter approaches are preferrable and yield more reliable results, given that the consideration of the aggregate trade would conceal the effects of exchange rate changes on the individual goods' exports and imports (Bahmani-Oskooee, Ratha, 2004c). Cheng (2020: 22) for instance mentions several combinations of depreciation effects, e.g. rise in exports plus fall in imports, rise only in exports, fall only in imports, rise in both, fall in both, and hence alternative shapes of the trade balance curve.

Secondly, the studies differed in terms of definition of the dependent variable: trade balance in absolute terms, trade balance as proportion of GDP, the ratio of the value of exports to imports, the value of the current account. The related issue in this respect (particularly when absolute values are used) was the conversion of the nominal trade, income and exchange rates to the real, using the price or volume indexes and the challenge of overcoming the aggregation bias across the goods used in the calculation of the indexes (Cheng, 2020: 23). The studies experimented with alternative price indexes, based on consumer or producer prices, or unit labour costs (Hsing, 2010). As for the dependent variables, the real exchange rate was typically supplemented by the domestic and foreign income (of the trade partner or of the rest of the world), as well as terms of trade (Senhadji, 1998), monetary (Yazici, 2006, 2010) and fiscal variables (Miles, 1979). A number of studies also controlled for political and macroeconomic factors: trade liberalisation (Brada et al, 1997) or the move from fixed to flexible exchange rate management (Lal, Lowinger, 2002).

Thirdly, regarding econometric methods and model specification, the research tended to adopt partial equilibrium models, that involved estimation of the trade balance (Akbostanci, 2004) or separate exports and imports equations (Jamilov, 2013; McDaniel, Agama, 2003). The studies that relied on general equilibrium methods were limited (the estimation of the J-curve as part of macroeconometric simulation of the Greek economy by Karadeloglou, 1990, stands as exception). As to the observation frequency, both yearly, quarterly and monthly data was used, albeit the use of monthly data was less common, while the use of quarterly data tended to better capture the variations in the J-curve. The use of econometric methods mirrored the development of econometrics in general. The earlier studies relied on linear regression (Bahmani-Oskooee, 1985) and simultaneous equations model (Arize, 1987), while the later research included time series models, such as Johansen cointegration or Granger causality (Hacker, Hatemi-J, 2003), non-parametric kernel estimation technique (Mahmud et al, 2004), vector autoregression (VAR) models (Kim, 2012), linear regression in a log-log form or in a more general Box-Cox functional form (Hsing, 2010), linear regression with a sufficient number of polynomial distributed lags to capture change in the relationship and change in coefficient signs (Yazici, 2010), linear or asymmetric autoregressive distributed lag models (Nusair, 2017; Bahmani-Oskooee, Harvey, 2017). The use of panel data methods was uncommon, albeit some studies are notable (Hatemi-J, Irandoust, 2005).

The research outcomes have been mixed. The survey of 36 studies up until 2004 (Bahmani-Oskooee, Ratha, 2004c) indicated the support of the J-curve effect hypothesis in 12 cases, but the absence of the J-curve in 7 cases. The mixed results (J-curve in some but not all economies in the study) were observed in 6 studies. In addition, 10 studies demonstrated insignificant response of the trade variables to the real exchange rate changes, delayed response, or alternative shapes of the trade balance curve, such as the patterns mentioned by Magee (1973), the N-, M-, and I-curves. The similar diversity of outcomes has also been observed in the recent empirical research. A general conclusion can be made that the presence (or absence) of the J-curve or alternative relationships is a context-specific issue and the findings are likely to vary substantially depending on the economy, sector or time frame in question.

The research on the J-curve effect in services trade has been scant, the four papers standing as exception. While Wijeweera and Dollery (2013) found some evidence of the J-curve effect for Australian services sector, Prakash and Maiti (2016), in the study of Fijian trade balance, and Yazici (2010) in Turkish services trade, demonstrated that services trade balance is not highly sensitive to exchange rate changes. Cheng (2020) presented mixed findings: the J-curve effect was present in the total services trade, but not in every services category. The purpose of this paper is to provide further evidence on the interaction between exchange rate and services trade balance.

Methodology

Model

Following Rose and Yellen (1989) and Yazici (2010), we consider a trade balance model with four regressors, specified as:

$$LTB_{UK,t} = \alpha + \beta_1 LY_{UK,t} + \beta_2 LYROW_t + \beta_3 LREER_{UK,t} + LMBASE_{UK,t} + \varepsilon_t \tag{2}$$

,where $LTB_{UK,t}$, $LY_{UK,t}$, $LYROW_t$, $LREER_{UK,t}$ and $LMBASE_{UK,t}$ represent respectively the logarithms of the difference between exports and imports, the UK gross domestic product (GDP), the 'rest of the world' GDP (the aggregate GDP of the Group 20 / G-20 economies minus GDP of the UK), and the real effective exchange rate of the UK, and the UK monetary base at time t . The terms α , β_1 , β_2 , β_3 are corresponding coefficients, and ε_t is a random error term. The model is estimated for the aggregate trade in services, as well as for individual service categories, specified further. We experiment with alternative specifications of the model: bi-variate, including $LREER_{UK,t}$ as the only regressor; and two multivariate, including exchange rate and GDP variables, or, additionally, the monetary variable.

The UK's real effective exchange rate (REER) is constructed as the average of the bilateral real exchange rates, i.e. RER of the UK with its trading partners weighted by the trade shares of the respective partner. The RER is defined as:

$$RER_{UK,t} = \frac{E_{UK} P_{UK}}{P_f} \tag{3}$$

,where E_{UK} is the nominal exchange rate with units of foreign currency per one unit of pound sterling, and P_{UK} and P_f are UK and foreign prices. For the purpose of RER calculation, we used two alternative price (cost) indexes: consumer price index (CPI) and unit labour costs, each having respective advantages and disadvantages (we denote the respective real effective exchange rates as REER-CPI and REER-UL).[2] The depreciation (appreciation) of the UK currency is indicated when REER

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[2] While CPI, as adjusting factor in RER calculation, excludes capital goods, and is affected by the country-specific basket weight, taxes, subsidies and price policies, the unit labour cost deflator tends to vary across the business

and RER decline (rise).

We expect the negative relationship between the UK GDP and trade balance, as long as increase in UK GDP leads to the increase in imports, and positive relationship between the two variables, if domestic production of importables grows faster that domestic consumption of importables (Magee, 1973). The effect of the 'rest of the world' GDP on the UK trade balance via the growth of the UK exports is hypothesized to be positive. The monetary base variable is likely to have negative effect on the trade balance (the growth of money would be interpreted by economic agents as increase in wealth and would trigger higher spending on imported goods), unless money represents a smaller proportion of the total wealth, is not perceived as total wealth, or does not trigger greater spending (Miles, 1979, Yazici, 2010: 169). The J-curve is present if the trade balance is defined as the ratio of export to import value (or as the difference between export and import value), and the signs of the short and long-run coefficients of REER are respectively positive and negative. Likewise, the J-curve effect holds, if the trade balance is given as the ratio of import to export value (or the difference between import and export value), and the signs of the short and long-run coefficients are negative and positive).

Data

We consider the UK economy as the industrialised economy with one of the largest shares of services in GDP and foreign trade and the absolute value of services exports among the OECD economies, and focus on the trade in aggregate services and 5 service components (transport, travel, commercial services, other services, and goods-related services). The data on the exports and imports of the services in aggregate, and the service components is available for the period that covers 60 quarters (Quarter 1 of 2005 to Quarter 1 of 2019).

The trade in services data is provided by UNCTAD (United National Conference on Trade and Development), based on collaborative work of the UNCTAD, World Trade Organisation (WTO) and International Trade Centre (ITC).[3] The data is reported in the current US dollars (following the conversion of the data in national currency to US dollars using International Monetary Fund/IMF period average exchange rates). The categorisation of services' types follows IMF *Balance of Payments and International Investment Position Manual* (IMF, 2009). The 'transport services' trade covers all modes of transport, as well as postal and courier and supporting and auxiliary services. 'Travel services' trade includes personal and business travel or the mix of the two, as well as local transportation, accommodation and food-serving services. 'Goods-related services' cover manufacturing services on physical inputs and maintenance and repair services. 'Commercial services' category is presented as memorandum item, encompassing other categories and pertains to all services, except government-related or government-provided ones. 'Other services' include a broad range of activities, such as construction, insurance, pension, financial services, charges for the use of intellectual property, personal, cultural and recreational activities, telecommunication, computer and information services, as well as government services and unallocated services. The trade balance measure is constructed as the ratio of the value of exports (of the aggregate services or sub-categories) to the value of imports, making it unnecessary to calculate the real exports and imports, and avoiding the problem of non-existent logarithms of the trade balance (e.g. when there is persistent trade deficit or the sign of the trade balance alternates between positive and negative, as is the case of transport and travel services in this paper).

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cycle and rests on additional assumptions (equality of prices of traded goods across the countries and the constant capital-labour ratios).

[3] The data is available at https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=en, in the 'Trade trends' folder, as 'Services (BPM6: Trade and Growth by Main Service-Category, Quarterly). The data has been accessed on 1 August 2020.

The quarterly GDP data for the UK and G-20 group was obtained from the OECD *Quarterly National Accounts* database.[4] The seasonally adjusted quarterly GDP by expenditure was measured at constant prices (using the volume index with the base in 2015) in the US dollars (using the relevant purchasing power parities). To ensure consistency with other variables, the base of the volume index was changed to 2010, so that real quarterly GDP is presented in 2010 constant prices. The total GDP for the G-20 group less GDP of the UK was used as a proxy for the 'rest of the world' GDP, given that the bulk of the trade in goods and services is conducted within this economic group.

The quarterly real effective exchange rate index was sourced from the IMF *International Financial Statistics*.[5] The calculation of the index relied on a broader range of trade partners, with the trade-based weight updated on a regular basis (every three years). Two alternative deflators were used - consumer prices index and the unit labour costs, both indices having base in 2010 (Zanello, Desruelle, 1997).

The missing observation data in the last quarter(s) was filled using the estimates of the linear regression with a trend term (exports and imports of transport, travel, goods-related and other services in the UK in Q4 2019).

Econometric method

As a first step we ascertain the integration order and unit root properties of the series and employ a battery of unit root tests with or without breaks. The Augmented Dickey-Fuller (ADF) that we conduct first is based on the first-order autoregressive process $Y_t = \phi_1 Y_{t-1} + \varepsilon_t$ and does not incorporate any structural breaks (Dickey, Fuller, 1981). The functional forms of the ADF test with alternative specification of deterministic term (constant or constant plus trend) are given as:

$$\Delta Y_t = \alpha + \psi Y_{t-1} + \beta t + \varsigma_1 \Delta Y_{t-1} + \varsigma_2 \Delta Y_{t-2} + \ldots + \varsigma_k \Delta Y_{t-k} + \varepsilon_t \tag{4}$$

and

$$\Delta Y_t = \alpha + \psi Y_{t-1} + \varsigma_1 \Delta Y_{t-1} + \varsigma_2 \Delta Y_{t-2} + \ldots + \varsigma_k \Delta Y_{t-k} + \varepsilon_t \tag{5}$$

,where α , t and β are the intercept, trend and coefficient of the trend, k is the lag order of the first-differenced terms ΔY_{t-k} introduced to remove serial correlation, ε_t is the error term, ϕ_1 is the autoregression parameter, and $\psi = \phi - 1$. The unit root null hypothesis ($\psi = 0, \phi = 1$) is contrasted with the alternative hypothesis of (trend) stationarity ($\psi < 0, |\phi| < 1$). The test's null hypothesis is evaluated by the test statistic that is represented by the conventional t-ratio from the Equation (5), $t_\psi = \hat{\psi} / s.e(\hat{\psi})$, is compared to the test's relevant critical values.

The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test is a stationarity test that likewise does not assume breaks in the series and has the reverse order of hypotheses: the null hypothesis of (trend-)stationarity and the alternative hypothesis of a unit root (Kwiatkowski et al, 1992). It complements ADF and other unit root tests by testing stationarity directly and confirming the unit root tests' results (e.g. rejection of the stationarity null in KPSS coupled with non-rejection of the unit root null in the ADF), particularly in shorter series. The test is based on the model:

$$\Delta Y_t = \alpha + \beta_1 t + \phi_t + \varepsilon_t \tag{6}$$

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[4] The data is available at 'OECD.Stat' web page - https://stats.oecd.org/Index.aspx?DataSetCode=QNA The data has been accessed on 1 August 2020. The quarterly GDP and the volume index variables are VPVOBARSA and VIXOBSA.

[5] The data is available at 'IMF Data, Access to Macroeconomic and Financial Data' web page - https://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B&sId=1409151240976. The data has been accessed on 1 August 2020.

$$\phi_t = \phi_{t-1} + u_t \tag{7}$$

,where α and t are deterministic components (constant and trend), ε_t is integrated of order zero and may be heteroskedastic, and ϕ_t is a random walk with variance σ_u^2 , $u_t \sim i.i.d(0, \sigma_u^2)$. The null hypothesis is that $\sigma_u^2 = 0$ and ϕ_t is a constant, while the alternative is that $\sigma_u^2 > 0$. The KPSS statistic is derived using the cumulative residual function from the regression of the variable on its deterministic components ($\hat{S}_t = \sum_{j=1}^{t} \hat{u}_j$) and the long-run variance of ε_t ($\hat{\lambda}^2$) as follows (Kwiatkowski et al, 1992: 163-5):

$$KPSS = \left(T^{-2} \sum_{t=1}^{T} \hat{S}_t^2 \right) / \hat{\lambda}^2 \tag{8}$$

Perron (1989) argued that in contrast to Nelson and Plosser (1982) findings, most of the economic time series do not contain unit roots and are stationary, while the shocks that have permanent effects on the series are infrequent and associated with major economic perturbations. Thus, the ADF and KPSS tests likely suffer from the unit root bias, i.e. the non-rejection of the unit root null hypothesis if structural breaks are not accounted for. While the early unit root tests with structural break relied on exogenous definition of the break (imposition of the break date), Zivot-Andrews (ZA) test allows endogenous determination of the timing of the break (Zivot, Andrews, 1992). The null hypothesis of ZA test is of a unit root with drift and without structural break, while an alternative is of a trend stationarity with break (the latter modelled as a change in the level of the series, in the slope of the trend, or in both, as follows):

$$\Delta Y_t = c + \alpha Y_{t-1} + \beta t + \phi DU_t + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \mu_t \tag{9}$$

$$\Delta Y_t = c + \alpha Y_{t-1} + \beta t + \psi DT_t + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \mu_t \tag{10}$$

$$\Delta Y_t = c + \alpha Y_{t-1} + \beta t + \phi DU_t + \psi DT_t + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \mu_t \tag{11}$$

In all three specifications, $\alpha = 0$ and $\alpha < 0$ under the null and alternative hypotheses respectively, and the break date that corresponds to rejection of the null is determined by the minimisation of a one-sided t-statistic of $\hat{\alpha} = (\alpha - 1) = 1$ in the above equations. The dummy variables representing structural changes are defined as $DU_t = 1$ if $t > TB$ and zero otherwise, and $DT_t = t - TB$ if $t > TB$ and zero otherwise, where TB is the timing of the change.

The ZA test and its later extensions does not assume structural break under the null hypothesis, thus bringing potentially incorrect conclusions (the rejection of the null in ZA test indicates the rejection of the unit root null without breaks, but if the break is indeed present the null rejection will point to the false conclusion of the trend stationarity with breaks, while the series may be in fact non-stationary with breaks). The Lee-Strazicich (LS) tests attempt to remedy the problem by assuming the unit root with breaks under the null hypothesis and the trend stationarity with breaks under the alternative (Lee, Strazicich, 2003; 2004). The test allows two specifications (Model A or ‘crash’ model, where series undergo abrupt change in the level and no change in the trend rate, and Model C or ‘break’ model that has simultaneous change in both level and trend) and includes up to two breaks. The LS test is based on a data-generating process:

$$Y_t = \delta' Z_t + e_t \tag{12}$$

$$e_t = \beta e_{t-1} + \mu_t \tag{13}$$

,where Y_t is a tested variable, μ_t is an independent and identically distributed error term, and $Z_t = \left[1, t, D_{1t}, D_{2t}, DT_{1t}^*, DT_{2t}^*\right]$ is a matrix of exogenous variables (that includes trend, and the dummies that represent intercept shifts and changes in the trend slope). $D_{jt} = 1$ and $DT_{jt} = 1$ for $t \geq TB_{Bj} + 1$ and zero otherwise, where $j = 1, 2$. Assuming that $\tilde{S}_t$ is a de-trended series of Y_t, the LM test statistic is obtained from:

$$\Delta Y_t = d' \Delta Z_t + \phi \tilde{S}_{t-1} + \sum Y_i \Delta \tilde{S}_{t-i} + \varepsilon_t \tag{14}$$

,where Δ is a first-difference operator, ε_t is a usual stochastic disturbance term, and the $\Delta \tilde{S}_{t-i}$ is the additional augmentation term to fix the serial correlation. A null hypothesis is supported if in Equation (14) $\phi = 0$ and the relevant t-test statistic is above the test's specified critical value.

The outcomes of the unit root and stationarity tests give indication as to the preferred estimation method for the trade balance equation: VECM model if all variables in the equation are I(1) and are cointegrated; VAR model in differences if variables are I(1) and not cointegrated; VAR model in levels if variables are stationary and not cointegrated; and autoregressive distributed lags (ARDL) model if the variables have mixed order of integration and are cointegrated. As shown further the integration properties of the data pointed to the use of the latter model.

The use of ARDL model (in linear or non-linear form) is justified on several grounds (Pesaran, Shin, 1999; Pesaran et al, 2001). As opposed to Johansen-Juselius and Engle-Granger cointegration methodologies that require the uniform order of integration of all variables in question, it is flexible in terms of the integration order of the variables, as long as none of the variables is I(2) , i.e. contain unit root when expressed in the first differences. It examines the relationships among the variables in a single equation; hence, in contrast to the system approaches (VAR, VECM), it does not require specifying the order of variables in the system or determining the more endogenous and the more exogenous variables. It also avoids the potential endogeneity problem, by allowing a flexible lag structure of the dependent and independent variables. Lastly, as noted by Haug (2002), it tends to deliver more consistent results in smaller datasets.

In the linear ARDL, the first difference of the dependent variable is regressed against its own lags, the lags of forcing variables, and the lagged first differences of both types of variables. Notation-wise, the ARDL model is specified as follows:

$$\begin{aligned}\Delta LTB_{UK,t} &= \varphi_0 + \varphi_1 LTB_{UK,t-i} + \varphi_2 LY_{UK,t-i} + \varphi_3 LYROW_{t-i} + \varphi_4 LREER_{UK,t-i} + \varphi_5 LMBASE_{UK,t-i} + \\ &+ \sum_{i=1}^{p} \psi_1 \Delta LTB_{UK,t-i} + \sum_{j=1}^{q} \psi_2 \Delta LY_{UK,t-j} + \sum_{k=1}^{q} \psi_3 \Delta LYROW_{t-k} + \sum_{l=1}^{q} \psi_4 \Delta LREER_{UK,t-l} + \\ &+ \sum_{m=1}^{q} \psi_5 \Delta LMBASE_{UK,t-m} + \varepsilon_t \end{aligned} \tag{15}$$

, where lagged variables capture the long-run relationships with φ_0 , φ_1 , φ_2 , φ_3 , φ_4 and φ_5 being the long-run coefficients, and lagged differenced variables represent the error-correction dynamics with ψ_1 , ψ_2 , ψ_3 , ψ_4 and ψ_5 being the short-run coefficients. The first-difference operator is given as Δ , and a white noise error term as ε_t . The optimal lag structure is determined by one of the conventional criteria (Akaike or Schwarz Bayesian, the former typically selecting a greater number of lags).

The bounds test (Pesaran et al, 2001) is conducted to establish the long-run relationship among the variables. The null hypothesis of no cointegration ($H_0 : \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = 0$) is contrasted with an alternative hypothesis of the presence of cointegration ($H_A : \varphi_1 \neq \varphi_2 \neq \varphi_3 \neq \varphi_4 \neq \varphi_5 \neq 0$). The bounds test' Wald F-statistic is compared to the test's upper and lower critical bounds, I(0) and I(1). The critical bounds are calculated on the assumption that all variables are respectively stationary in levels or contain the unit root. The null hypothesis of no cointegration is rejected if the test statistic exceeds I(1), and is not rejected if it is below I(0). The bounds test is inconclusive, when test statistic falls within the bounds. In such case, following Kremers et al (1992), and Bahmani-Oskooee and Nasir (2004a: 485), the cointegration is established by the significance of the error correction term (EC_{t-1}) in the error-correction representation of ARDL:

$$\Delta LTB_{UK,t} = \theta_0 + \sum_{i=1}^{p} \theta_1 \Delta LTB_{UK,t-i} + \sum_{j=1}^{q} \theta_2 \Delta LY_{UK,t-j} + \sum_{k=1}^{q} \theta_3 \Delta LYROW_{t-k} + \\ + \sum_{l=1}^{q} \theta_4 \Delta LREER_{UK,t-l} + \sum_{m=1}^{q} \theta_5 \Delta LMBASE_{UK,t-m} + \phi EC_{t-1} + \varepsilon_t \quad (16)$$

,where ϕ is the error-correction term coefficient that represents the speed of adjustment to long-run equilibrium.

The long-run coefficients are obtained from:

$$\Delta LTB_{UK,t} = \gamma_0 + \gamma_1 LTB_{UK,t-i} + \gamma_2 LY_{UK,t-i} + \gamma_3 LYROW_{t-i} + \gamma_4 LREER_{UK,t-i} + \\ + \gamma_5 LMBASE_{UK,t-i} + \varepsilon_t \quad (17)$$

As an extension of a linear ARDL, we also consider non-linear (asymmetric) ARDL model (Shin et al, 2013) that, in addition to linear ARDL features (differentiation between long- and short-run effects), allows for an asymmetric response of the trade balance to depreciations versus appreciations (an extension that captures the variation in price elasticities and expectations following particular type of exchange rate change). Keeping notation similar to Equation (15), we represent non-linear ARDL as:

$$\Delta LTB_{UK,t} = \zeta_0 + \zeta_1 LTB_{UK,t-i} + \zeta_2 LY_{UK,t-i} + \zeta_3 LYROW_{t-i} + \zeta_4 LREER^{+}_{UK,t-i} + \zeta_5 LREER^{-}_{UK,t-i} + \\ + \zeta_6 LMBASE_{UK,t-i} + \sum_{i=1}^{n1} \psi_1 \Delta LTB_{UK,t-i} + \sum_{j=1}^{n2} \psi_2 \Delta LY_{UK,t-j} + \sum_{k=1}^{n3} \psi_3 \Delta LYROW_{t-k} + \sum_{l=1}^{n4} \psi_4 \Delta LREER^{+}_{UK,t-l} + \\ + \sum_{m=1}^{n5} \psi_5 \Delta LREER^{-}_{UK,t-m} + \sum_{n=1}^{n6} \psi_6 \Delta LMBASE_{UK,t-n} + \upsilon_t \quad (18)$$

,where the partial sums of positive and negative changes in the real exchange rate ($LREER^{+}_{t}$ and $LREER^{-}_{t}$) are calculated as:

$$LREER^{+}_{t} = \sum_{j=1}^{t} \Delta LREER^{+}_{j} = \sum_{j=1}^{t} \max(\Delta LREER_j, 0) \quad (19)$$

$$LREER^{-}_{t} = \sum_{j=1}^{t} \Delta LREER^{-}_{j} = \sum_{j=1}^{t} \min(\Delta LREER_j, 0) \quad (20)$$

In the linear ARDL model the J-curve is indicated when the short- and long-run coefficients of REER (i.e. ψ_4 and φ_4) are significant and are respectively positive and negative. Alternatively, following Rose and Yellen (1989) interpretation, the J-curve is present when coefficient of the first difference of REER is negative at lower lags, but positive at higher lags. In the non-linear ARDL, the presence of the J-curve is ascertained if $\Delta LREER^{-}_{UK,t} > 0$ and $LREER^{-}_{UK,t} < 0$. In the absence of J-curve, the Marshall-Lerner (long-term) condition is satisfied if $\varphi_4 < 0$ in linear and $\delta_5 < 0$ in non-linear ARDL.

Similarly to linear ARDL, the cointegration is examined by means of F-test, where the null hypothesis of no cointegration ($H_0 : \zeta_1 = \zeta_2 = \ldots = \zeta_6 = 0$) is contrasted with a cointegration alternative ($H_A : \zeta_1 \neq \zeta_2 \neq \ldots \neq \zeta_6 \neq 0$) and the respective statistics is examined with reference to $I(0)$ and $I(1)$ critical bounds. As a last step, the appropriateness of the non-linear ARDL is established by the long-run symmetry test with the null hypothesis of $\delta^{+} = -\zeta_4 / \zeta_1 = \delta^{-} = -\zeta_5 / \zeta_1$.

Empirical results

As a first step of empirical analysis we examine the integration properties of the variables using the unit root tests with or without breaks. Table 1 demonstrates the mixed order of integration of the series, with all of them being either I(0) or I(1) and none being I(2). The latter property makes it appropriate to use ARDL model that requires that none of the variables contain unit root when expressed in the first differences. The ADF test generally indicates the I(1) in most of the variables, with the exception of the logarithm of the GDP (test specification with constant plus trend), the logarithm of the unit labour costs based real exchange rate and the trade balance for ‘other services’. The KPSS test points to the level stationarity in both real exchange rate variables, and trend stationarity in the logarithms of the rest of the world GDP, the unit labour costs based real exchange rate, and the trade balance in ‘other services’ category. The ZA test was conducted with three alternative deterministic components (intercept, or trend, or both). The test indicated level stationarity with break for the logarithms of GDP and ‘rest of the world’ GDP, and trend stationarity with break for these variables as well as for the logarithm of the trade balance in transportation services. The LS test that was implemented in four alternative specifications (‘crash’ and ‘break’ models with one or two breaks), where ‘crash’ model contrasts unit root with break and the stationarity with break(s) in the intercept, while the ‘break’ model considers stationarity with break(s) in both intercept and trend. The test demonstrated that the logarithm of the ‘rest of the world’ GDP was stationary with break(s) in every specification, while the logarithms of the unit labour costs based real exchange rate and the trade balance in travel services were stationary with break(s) in two specifications (respectively the ‘break’ and ‘crash’ models with two breaks and ‘break’ model with two and one breaks).[6] The logarithm of GDP was stationary in the ‘crash’ model with a single break, while all other variables were stationary with breaks in three out of four specifications.

Having ascertained that none of the variables is integrated of order two, we implement linear or non-linear ARDL following the conventional procedure.

Firstly, the unrestricted error-correction model was formulated with a sufficient number of lags to tackle the potential serial correlation problem. To address this issue, but also given particular interest in the variation of REER coefficients at different lags, Akaike information criterion was used instead of Schwarz Bayesian, since the former tends to select a greater number of lags and avoids the problem of under-fitting the model (selecting simpler model with smaller number of lags). A maximum number of lags for the lag selection varied across the models and the categories of services, determined by the need to ensure correct specification of the model (e.g. up to six lags in the non-linear ARDL model estimated for the travel services with REER based on CPI versus a maximum of two lags in a similar

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[6] We do not attribute the identified break dates to any particular economic (political) event or development, since the ZA and LS are the unit root tests with breaks, not the tests of the structural breaks (in contrast, for instance, to Bai-Perron test). Respectively, the break date is the time point when the test statistics is minimised, not the actual timing of the break.

model estimated for the goods related services). In a number of instances, a fixed lag structure was imposed (e.g. in the case of linear ARDL model for the travel services, using REER based on unit labour costs).

Secondly, we conducted the requisite diagnostic tests: Jarque-Bera normality test, Breusch-Pagan serial correlation in the residuals LM test, Breusch-Pagan heteroskedasticity test, Ramsey RESET test of model specification and the tests of model stability, as well as cumulative sum and cumulative sum squared of recursive residuals tests (CUSUM and CUSUMSQ). The autocorrelation of the model's residuals was also inspected via Q-statistic and its probability in the correlogram graph.

Thirdly, the bounds test was conducted using the unrestricted model, an important requirement, given a note by Pesaran et al (2001: 312) and Gürtler (2019: 485) that failure to keep the coefficients of lagged changes unrestricted may result in tests' suffering from a pre-testing problem. However, the imposition of restrictions after the cointegration test potentially brings a more parsimonious and accurate estimates.

Fourthly, we used ARDL with restricted constant and no linear trend to estimate a long-run equilibrium relationship and the short-run dynamic effects (in line with previous studies of J-curve, e.g. Waliullah et al, 2010). We additionally, experimented with unrestricted constant and restricted trend as an alternative specification (the inclusion of trend being justified by the trending behaviour of GDP variables, and the fact that cointegration tests concern with identification of common stochastic trends (Gürtler, 2019: 483). The estimates however are not fundamentally different from a restricted constant model (in the sense that in neither aggregate nor disaggregated trade cases, the J-curve effect was identified), and hence are not reported to conserve space.

The findings are presented in Tables 2 to 5. A total of 25 models were estimated and 23 of them were stable (as evidenced by CUSUM and CUSUMSQ tests), albeit in a number of cases year dummies were introduced to ensure stability. The dummies corresponded to the structural breaks that most commonly occurred during the 2017-19 period, but the determination of the breaks was made based on the observation of the residuals, rather than on formal test, such as Bai-Perron. CUSUMSQ indicated instability in the case of non-linear ARDL models estimated for travel services, while CUSUM confirmed the absence of any instability of the coefficients. As far as model specification is concerned, we failed to reject the RESET test' null hypothesis of correct specification at 5% significance level in all cases except REER-CPI based linear ARDL model for goods-related and other services, and REER-CPI based non-linear ARDL for travel services, where the null hypothesis held at 1% level. With regard to Breusch-Pagan-Godfrey LM test of heteroskedasticity, we failed to reject the null of no heteroskedasticity at the 5% significance level and in the case of the non-linear REER-UL based ARDL model for the travel services at the 1% level. In all cases (except for the linear REER-UL based ARDL model for travel services), we failed to reject, at the conventional significance levels, the Jarque-Bera null hypothesis of normally distributed residuals. The Breusch-Pagan LM test null hypothesis of no serial correlation in the residuals was not rejected in any of the cases except for some of the REER-CPI based ARDL models for the travel services (in these cases, however, the F-test version of the test as well as Q-statistic in the correlogram confirmed the absence of serial correlation). In the non-linear ARDL model with REER-UL, the null hypothesis of the long-run symmetry has been rejected for the aggregate services, and the commercial, goods-related and other services, while in the model with REER-CPI, the null hypothesis has been rejected only for the aggregate and goods-related services.

In all models the error correction term (ECT) belonged to $\left(0,-1\right)$ range and was significant, thus indicating the presence of cointegration among the variables (Kremers et al, 1992; Banerjee et al, 1998). Its absolute size ranged from 0.336 to 0.980, thus indicating a rather fast adjustment speed (with 33.6% and 98% of disequilibria being corrected in the period following the shock). In the case of linear ARDL models, the bounds F-test null hypothesis of no cointegration was rejected at one of the conventional significance levels in all cases, with test statistics exceeding I(1) critical bounds. For the goods-related services, the test was inconclusive, because the statistics fell within I(0) and I(1) bounds; in this case, cointegration was established based on the significance of ECT. In non-linear ARDL models, the null of no cointegration was likewise unambiguously rejected. For travel services, we failed to reject the null, as the test statistics was below I(0) at all or most significance levels.

In all models (except for the REER-UL based non-linear ARDL model for travel services), the long-run coefficient of the logarithm of GDP was negative, in line with theoretical predictions and previous empirical studies. It was also significant in 21 models out of 25 estimated. The long-run coefficient of the logarithm of the 'rest of the world' GDP was positive in all cases except for the travel services in the REER-UL based non-linear ARDL model, and significant in 21 models out of 25 as well. Overall, the results confirm the Keynesian hypothesis that domestic economic growth leads to the deterioration of the services trade balance through the increase in imports, while the overseas economic growth improves the balance through the growth of services exports.

The long-run coefficient of the logarithm of the monetary base was negative in 15 models out of 25 (but significant in 7 models), mostly for the aggregate, commercial, and other services, and less so for the goods-related and travel services (negative in two and one models respectively). The wealth effect (increase in imports expenditure and trade balance deterioration due to perception of greater wealth, following increase in monetary base) was thus confirmed. On the other hand, the coefficient was positive in all models estimated for the transport services, hence for the monetary variable, the findings are likely to be service-specific.

A conventional definition of the J-curve effect implies positive short-run and negative long-run coefficients of REER in linear model, and positive $\Delta LREER_{UK}^{-}$ and negative $LREER_{UK}^{-}$ in a non-linear model. For models where both types of coefficients are significant, we conclude that J-curve effect was not observed in any of the linear or non-linear ARDL models. The long-run coefficient of the logarithm of $LREER_{UK}$ or $LREER_{UK}^{-}$ was negative only in two models (but not significant in either of them), and positive and significant in 13 models out of 25, indicating that depreciations tend to lead to the deterioration in the aggregate or disaggregated trade balance in the long-run, contra the J-curve effect and Marshall-Lerner condition.

The trade balance deterioration in both short- and long-run was observed in 7 models (including 3 models for the transport services). The short-run improvement followed by a long-run deterioration was demonstrated in 6 models (models for transport, travel and other services). We note that due to variation in the sign of $\Delta LREER_{UK}$ and $\Delta LREER_{UK}^{-}$ in the transport services, the findings in this category are 'fuzzy' with trade balance following multiple behaviour patterns (e.g. deterioration at one lag but improvement at the following lag). We also note that in four models both types of coefficients were insignificant.

According to Rose and Yellen (1989) alternative definition of the J-curve effect, the signs of the early lags of the differenced REER are supposed to be positive but turn negative at later lags in the linear models. Given that in many models only one lag of $\Delta LREER_{UK}$ was selected, this version of the effect could be examined only in 4 models. The hypothesised behaviour (provided that most of lags were significant) was observed in models for the transport services (however, the J-curve was not following the 'conventional' pattern, with two periods of trade balance deterioration and improvement instead of one).

The lack of evidence of the J-curve effect may be attributed to the data linearity assumption that underpins the linear ARDL. However, the estimation of the non-linear ARDL and respective introduction of asymmetric effects and the differentiation of the effects from appreciations and depreciation did not deliver better results. The finding that there is no J-curve and Marshall-Lerner condition in either linear or non-linear model is not uncommon. As far as studies that employed linear ARDL are concerned, the rejection of the J-curve hypothesis was documented in a number of instances (e.g. Nusair, 2017, in the context of European transition economies, or Narayan, 2006, for the trade of China with the US). While non-linear ARDL models are generally more statistically robust and tend to identify J-curve effect in a greater number of cases compared to the linear models, a number of studies nonetheless demonstrated the absence (or rather limited presence) of the J-curve even when non-linear ARDL is used. These studies included Akoto and Sakyi (2019) did not identify the J-curve in the non-linear model in the case of aggregate trade of Ghana; Sivrikaya and Ongan (2019), who examined, using non-linear ARDL, the UK bilateral trade with seventeen trading partners but did not detect J-curve in any of the cases; and Bahmani-Oskooee et al (2016) who applied non-linear ARDL to the bilateral trade of the UK with six major trading partners, but identified significant effect only in the case of the UK-US trade (despite the presence of asymmetries across the cases, and meaningful diagnostic statistics). In the papers that generally give support to the J-curve phenomenon based on non-linear ARDL, the effect was not always observed in every or the majority of cases, e.g. in five out of twenty-one China's trading partners (Bahmani-Oskooee et al, 2018), or in three out of eight Pakistan's partners (Iqbal, et al, 2021).

For the purpose of robustness checking we also estimated bi-variate model, including $LREER_{UK,t}$ as the only regressor; and another multivariate model that excludes the monetary base variable (to conserve space, the results are not presented). In a bi-variate model, the bounds test null hypothesis of no cointegration was not rejected in a linear ARDL model with REER-UL, was rejected in linear ARDL model with REER-CPI and non-linear ARDL with REER-UL and REER-CPI. In those cases, where cointegration was confirmed, the $LREER_{UK,t}$ and $LREER^{-}_{UK,t}$ coefficients were insignificant with positive or negative signs (hence no J-curve effect or Marshall-Lerner condition). For the multivariate models with no monetary variable, the cointegration was confirmed (albeit in most cases, using the t-statistics of the ECT term), but the coefficients of $LREER_{UK,t}$ and $LREER^{-}_{UK,t}$ were either positive or insignificant and negative (likewise indicating the absence of the J-curve or Marshall-Lerner condition).

Table 1. Unit root tests results

Variable	ADFc	ADFct	KPSSc	KPSSct	ZAc	ZAt	ZAct	LS A	LS AA	LS C	LS CC
LGDP	0.400	-1.795	2.461	0.339	**-7.150**	-3.502	**-7.003**	-3.859	-3.816	-3.925	-5.676
D(LGDP)	-4.313	-4.446	0.099	0.084	2008Q3	2009Q2	2008Q3	2012Q1	2008Q4 2012Q1	2012Q1	2009Q2 2015Q4
LGDPROW	-0.741	**-4.448**	0.993	0.153	**-5.594**	-4.532	**-6.628**	**-4.180**	**-4.718**	**-4.809**	**-9.910**
D(LGDPROW)	-4.128	-4.132	0.098	0.061	2008Q4	2010Q2	2008Q3	2009Q1	2008Q3 2009Q2	2009Q4	2008Q2 2010Q2
LREERCPI	-2.067	-2.086	0.404	0.149	-3.589	-3.587	-3.623	-2.667	-2.890	-3.996	-5.547
D(LREERCPI)	-5.361	-5.373	0.106	0.064	2008Q1	2011Q3	2009Q1	2008Q3	2011Q1 2017Q3	2010Q1	2010Q1 2016Q1
LREERUL	-2.986	-2.401	**0.240**	0.122	-3.949	-3.460	-4.016	-3.414	-3.631	-3.599	-6.640
D(LREERUL)	-5.247	-5.193	0.057	0.056	2012Q2	2009Q1	2012Q2	2012Q1	2012Q1 2015Q2	2012Q1	2008Q3 2015Q4
LTBSERV	-2.382	-2.363	0.608	0.167	-4.033	-3.277	-3.979	**-4.626**	**-4.309**	**-6.127**	-6.017
D(LTBSERV)	-7.606	-8.116	0.260	0.052	2011Q2	2014Q3	2011Q2	2015Q2	2015Q2 2016Q4	2014Q3	2010Q3 2015Q1
LMBASE	-1.436	-1.892	0.462	**0.106**	-3.822	-2.634	-3.894	-3.427	-3.442	-3.350	-4.702
D(LMBASE)	-7.914	-7.963	0.184	0.086	2010Q3	2012Q1	2010Q2	2009Q3	2008Q4 2009Q3	2011Q3	2010Q2 2015Q2
LTRAN	-1.852	-0.275	0.540	0.160	-3.474	-4.626	-4.822	**-4.700**	**-4.702**	-3.858	-6.800
D(LTRAN)	-4.479	-4.936	0.221	0.064	2017Q4	2017Q4	2017Q2	2017Q2	2007Q3 2017Q2	2018Q2	2009Q4 2017Q3
LTRAV	-1.753	0.722	0.852	0.371	-1.488	-1.646	-1.942	-2.807	-3.490	-4.757	-6.295
D(LTRAV)	-14.659	-15.369	0.179	0.073	2010Q4	204Q4	2012Q4	2016Q4	2016Q4 2017Q2	2013Q4	2010Q3 2013Q4
LCOMMER	-2.474	-2.404	0.613	0.175	-4.058	-3.334	-3.947	**-4.463**	**-4.109**	**-6.077**	-6.020
D(LCOMMER)	-7.440	-7.976	0.130	0.046	2011Q1	2014Q3	2011Q1	2015Q2	2007Q3 2015Q4	2014Q3	2010Q3 2015Q1
LOTHER	-2.969	-3.200	0.502	**0.089**	-3.865	-3.396	-2.996	**-4.248**	**-4.293**	**-5.218**	-5.738
D(LOTHER)	-13.359	-13.451	0.151	0.058	2011Q1	2014Q3	2008Q1	2015Q4	2011Q3 2016Q2	2015Q3	2007Q3 2012Q3
LGOODS	-1.842	-2.831	0.403	0.170	-3.281	-3.844	-3.863	**-4.708**	**-5.557**	**-5.580**	-5.452
D(LGOODS)	-10.868	-10.910	0.190	0.039	2007Q4	2008Q2	2015Q1	2009Q3	2009Q3 2016Q2	2014Q4	2014Q3 2017Q1

Note. The ‘c’, ‘t’ and ‘ct’ subscripts indicate test specifications with constant, trend, and constant plus trend. LS A, LS AA, LS C and LS CC indicate respectively Lee-Strazicich test ‘crash’ and ‘break’ models with one or two breaks. The values in bold represent (trend) stationarity. KPSS test was implemented with quadratic spectral kernel estimation method and bandwidth automatic selection (Andrews bandwidth). The Zivot-Andrews (ZA) and Lee-Strazicich tests were conducted on the levels of variables.

Table 2. Linear ARDL results (REER based on real unit labour costs)

Variable	Aggregate		Transport		Travel		Commercial		Goods-related		Other	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
DLTB$_{(-1)}$	-0.465	(0.000)					-0.477	(0.000)	-0.156	(0.282)	-0.193	(0.096)
DLTB$_{(-2)}$	-0.293	(0.015)					-0.296	(0.016)	0.014	(0.917)	0.244	(0.037)
DLTB$_{(-3)}$	-0.546	(0.000)					-0.549	(0.000)	0.007	(0.959)	-0.155	(0.197)
DLTB$_{(-4)}$									0.310	(0.025)		
DLY	-2.818	(0.387)	-1.185	(0.529)	0.039	(0.780)	-2.660	(0.405)	-1.201	(0.742)	-1.134	(0.561)
DLY$_{(-1)}$					-0.025	(0.857)						
DLY$_{(-2)}$					0.252	(0.063)						
DLY$_{(-3)}$					0.248	(0.144)						
DLYROW	9.223	(0.000)	0.458	(0.707)	0.170	(0.328)	9.075	(0.000)	2.956	(0.279)	2.439	(0.086)
DLYROW$_{(-1)}$					-0.275	(0.206)						
DLYROW$_{(-2)}$					-0.103	(0.634)						
DLYROW$_{(-3)}$					-0.041	(0.806)						
DLREER	-1.114	(0.046)	0.529	(0.060)	0.030	(0.118)	-1.109	(0.044)	0.124	(0.839)	0.062	(0.852)
DLREER$_{(-1)}$			-0.896	(0.002)	0.019	(0.350)						
DLREER$_{(-2)}$			0.054	(0.857)	-0.004	(0.871)						
DLREER$_{(-3)}$			-0.933	(0.001)	-0.047	(0.031)						
DLMBASE	-1.439	(0.064)	0.508	(0.171)	0.028	(0.330)	-1.455	(0.058)	-0.842	(0.328)	-1.030	(0.028)
DLMBASE$_{(-1)}$					0.045	(0.117)						
DLMBASE$_{(-2)}$					0.025	(0.369)						
DLMBASE$_{(-3)}$					0.009	(0.738)						
Constant	51.254	(0.105)	-9.825	(0.016)	0.496	(0.097)	52.331	(0.101)	15.985	(0.384)	13.235	(0.148)
LY	-5.938	(0.033)	-1.047	(0.047)	-0.140	(0.002)	-5.740	(0.037)	-5.816	(0.008)	-1.090	(0.288)
LYROW	8.360	(0.021)	0.490	(0.269)	0.090	(0.042)	8.254	(0.024)	4.072	(0.043)	2.700	(0.015)
LREER	0.208	(0.807)	0.548	(0.003)	0.024	(0.083)	0.088	(0.921)	1.388	(0.056)	0.365	(0.287)
LMBASE	-3.821	(0.089)	0.501	(0.030)	0.001	(0.960)	-3.875	(0.097)	-0.098	(0.939)	-1.347	(0.046)
DUM					2019Q2				2017Q3			
ECT	-0.373	(0.000)	-0.909	(0.000)	-0.980	(0.000)	-0.358	(0.000)	-0.423	(0.000)	-0.418	(0.000)
R^2 adj	0.668		0.460		0.072		0.681		0.360		0.517	

F-test	4.255		8.594		4.142		4.177		3.459		5.045	
J-B	1.997	(0.368)	1.577	(0.455)	11.62	(0.003)	1.789	(0.409)	0.353	(0.838)	0.340	(0.844)
LM (F)	0.653	(0.526)	1.000	(0.376)	2.580	(0.092)	0.613	(0.546)	3.269	(0.048)	1.188	(0.314)
LM	1.650	(0.438)	2.434	(0.296)	7.990	(0.018)	1.553	(0.460)	7.409	(0.025)	2.809	(0.245)
Heterosk.	7.051	(0.721)	10.572	(0.306)	20.85	(0.530)	6.644	(0.759)	13.504	(0.197)	4.767	(0.782)
RESET	0.319	(0.751)	0.120	(0.905)	1.690	(0.101)	0.258	(0.798)	1.999	(0.052)	1.946	(0.058)
CUSUM	S		S		S		S		S		S	
CUSUMSQ	S		S		S		S		S		S	

Note. F-test, J-B, LM (F), LM, Heterosk., RESET, CUSUM and CUSUMSQ represent respectively bounds F-test, Jarque-Bera normality test, F-test version of the Breusch-Godfrey test of serial correlation, Breusch-Godfrey LM test of serial correlation, Breusch-Pagan-Godfrey LM test of heteroskedasticity, Ramsey regression equation specification error test, cumulative sum and cumulative sum squared of recursive residuals tests of stability. DUM and ECT indicate time dummy variables and the error correction term. p-values are put in the parentheses. 'S' indicates stability of the model. Formula-wise DLTB is an equivalent representation of $\Delta \ln TB$ in text (likewise for other variables).

Table 3. Non-linear ARDL results (REER based on real unit labour costs)

Variable	Aggregate		Transport		Travel		Commercial		Goods-related		Other	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
DLTB$_{(-1)}$	-0.323	(0.008)			-0.338	(0.016)	-0.323	(0.008)			-0.160	(0.184)
DLTB$_{(-2)}$	-0.214	(0.069)					-0.206	(0.082)			0.190	(0.099)
DLTB$_{(-3)}$	-0.487	(0.000)					-0.485	(0.000)			-0.206	(0.079)
DLY	-5.172	(0.140)	-2.006	(0.246)	0.080	(0.427)	-5.114	(0.139)	-5.637	(0.124)	-3.490	(0.084)
DLYROW	10.632	(0.001)	1.752	(0.221)	-0.224	(0.051)	10.406	(0.001)	11.225	(0.001)	6.502	(0.000)
DLYROW$_{(-1)}$												
DLYROW$_{(-2)}$												
DLYROW$_{(-3)}$												
DLREER^{+}	-3.573	(0.001)	-0.547	(0.297)	-0.050	(0.077)	-3.470	(0.001)	-3.083	(0.007)	-1.666	(0.010)
DLREER$^{+}_{(-1)}$					-0.099	(0.025)						
DLREER$^{+}_{(-2)}$					-0.110	(0.003)						
DLREER$^{+}_{(-3)}$					-0.089	(0.010)						
DLREER$^{+}_{(-4)}$					-0.061	(0.067)						
DLREER^{-}	1.166	(0.095)	0.987	(0.015)	0.079	(0.001)	1.102	(0.109)	1.379	(0.070)	1.007	(0.016)
DLREER$^{-}_{(-1)}$			-1.027	(0.005)	0.050	(0.032)						

DLMBASE	-0.845	(0.271)	0.869	(0.021)	0.021	(0.258)	-0.875	(0.248)	0.133	(0.873)	-0.689	(0.124)
Constant	-35.336	(0.162)	-25.229	(0.005)	2.986	(0.006)	-34.688	(0.163)	-79.099	(0.002)	-26.274	(0.071)
LY	-9.510	(0.001)	-2.289	(0.011)	0.103	(0.273)	-9.494	(0.001)	-14.765	(0.000)	-4.882	(0.002)
LYROW	12.455	(0.000)	2.280	(0.032)	-0.276	(0.037)	12.338	(0.000)	15.012	(0.000)	7.154	(0.000)
$LREER^{+}$	-2.518	(0.043)	-0.492	(0.259)	0.162	(0.001)	-2.582	(0.036)	-4.091	(0.005)	-1.648	(0.027)
$LREER^{-}$	1.805	(0.006)	0.696	(0.002)	-0.011	(0.640)	1.747	(0.007)	2.753	(0.000)	1.177	(0.002)
LMBASE	-1.389	(0.136)	0.659	(0.007)	0.024	(0.143)	-1.343	(0.144)	1.220	(0.039)	-0.724	(0.095)
DUM			2017Q2									
ECT	-0.588	(0.000)	-0.955	(0.000)	-0.713	(0.000)	-0.585	(0.000)	-0.751	(0.000)	-0.550	(0.000)
R^2 adj	0.657		0.426		0.426		0.670		0.274		0.509	
F-test	4.306		7.577		2.589		4.195		4.395		4.184	
J-B	3.912	(0.141)	1.121	(0.571)	3.067	(0.216)	3.718	(0.156)	2.117	(0.347)	1.802	(0.406)
LM (F)	0.853	(0.433)	1.492	(0.236)	0.513	(0.603)	0.841	(0.438)	1.228	(0.302)	1.323	(0.277)
LM	2.089	(0.352)	3.545	(0.170)	1.456	(0.483)	2.063	(0.357)	2.816	(0.245)	3.176	(0.204)
Heterosk.	4.746	(0.856)	13.852	(0.128)	24.125	(0.044)	4.826	(0.849)	1.308	(0.988)	5.191	(0.817)
RESET	0.507	(0.615)	1.034	(0.307)	0.928	(0.359)	0.589	(0.559)	1.208	(0.233)	1.097	(0.279)
Wald LR	14.710	(0.000)	2.070	(0.150)	0.329	(0.567)	15.603	(0.000)	16.558	(0.000)	22.594	(0.000)
CUSUM	S		S		S		S		S		S	
CUSUMSQ	S		S		US		S		S		S	

Note. As per Table 2. Wald LR is the test of long-run asymmetry. ‘US’ indicates instability of the model.

Table 4. Linear ARDL results (REER based on CPI)

Variable	Aggregate		Transport		Travel		Commercial		Goods-related		Other	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
$DLTB_{(-1)}$	-0.476	(0.000)					-0.490	(0.000)	-0.158	(0.270)	-0.190	(0.103)
$DLTB_{(-2)}$	-0.286	(0.018)					-0.290	(0.018)	0.013	(0.922)	0.249	(0.033)
$DLTB_{(-3)}$	-0.534	(0.000)					-0.539	(0.000)	0.008	(0.953)	-0.152	(0.193)
$DLTB_{(-4)}$									0.320	(0.019)		
DLY	-2.909	(0.376)	-1.994	(0.326)	0.208	(0.140)	-2.656	(0.409)	-0.750	(0.836)	-1.038	(0.597)
$DLY_{(-1)}$					0.115	(0.383)						
$DLY_{(-2)}$					0.352	(0.008)						

DLY$_{(-3)}$					0.326	(0.054)						
DLYROW	9.031	(0.000)	0.818	(0.543)	-0.039	(0.810)	8.832	(0.001)	3.143	(0.243)	2.483	(0.079)
DLYROW$_{(-1)}$					-0.299	(0.170)						
DLYROW$_{(-2)}$					-0.317	(0.126)						
DLYROW$_{(-3)}$					-0.051	(0.753)						
DLREER	-1.214	(0.051)	0.807	(0.017)	0.019	(0.335)	-1.232	(0.044)	0.119	(0.860)	0.061	(0.867)
DLREER$_{(-1)}$			-1.025	(0.002)	0.026	(0.212)						
DLREER$_{(-2)}$			0.227	(0.514)	0.017	(0.468)						
DLREER$_{(-3)}$			-0.958	(0.004)	-0.046	(0.045)						
DLMBASE	-1.556	(0.050)	0.573	(0.151)	0.003	(0.906)	-1.574	(0.044)	-0.982	(0.267)	-1.045	(0.028)
DLMBASE$_{(-1)}$					0.034	(0.215)						
DLMBASE$_{(-2)}$					0.035	(0.201)						
DLMBASE$_{(-3)}$					0.016	(0.554)						
Constant	52.452	(0.085)	-7.592	(0.151)	0.680	(0.026)	53.236	(0.085)	25.102	(0.197)	15.268	(0.089)
LY	-6.197	(0.058)	-2.473	(0.023)	-0.156	(0.014)	-5.682	(0.087)	-8.519	(0.005)	-1.736	(0.191)
LYROW	9.099	(0.009)	1.416	(0.066)	0.068	(0.208)	8.866	(0.012)	5.982	(0.006)	3.140	(0.004)
LREER	0.215	(0.857)	0.926	(0.010)	0.020	(0.289)	0.007	(0.996)	1.744	(0.081)	0.433	(0.340)
LMBASE	-4.211	(0.087)	0.505	(0.090)	0.017	(0.417)	-4.325	(0.096)	-0.297	(0.827)	-1.376	(0.046)
DUM			2015Q3		2010Q3, 2019Q2, 2018Q1				2017Q3			
ECT	-0.353	(0.000)	-0.756	(0.000)	-0.939	(0.000)	-0.336	(0.000)	-0.406	(0.000)	-0.419	(0.000)
R^2 adj	0.664		0.412		0.192		0.678		0.353		0.512	
F-test	4.104		6.280		5.513		4.057		3.319		4.892	
J-B	1.717	(0.424)	1.170	(0.557)	5.620	(0.060)	1.539	(0.463)	0.398	(0.819)	0.325	(0.850)
LM (F)	0.756	(0.476)	0.902	(0.413)	4.110	(0.027)	0.712	(0.496)	3.180	(0.052)	1.125	(0.334)
LM	1.903	(0.386)	2.255	(0.324)	12.367	(0.002)	1.795	(0.408)	7.234	(0.027)	2.666	(0.264)
Heterosk.	6.699	(0.754)	18.097	(0.053)	29.435	(0.204)	6.483	(0.773)	13.797	(0.182)	5.048	(0.752)
RESET	0.044	(0.965)	0.006	(0.995)	1.315	(0.199)	0.773	(0.948)	2.034	(0.048)	2.040	(0.047)
CUSUM	S		S		S		S		S		S	
CUSUMSQ	S		S		S		S		S		S	

Note. As per Table 2.

Table 5. Non-linear ARDL (REER based on CPI)

Variable	Aggregate		Transport		Travel (1)		Travel (2)		Commercial		Goods-related		Other	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
$DLTB_{(-1)}$	-0.455	(0.000)			-0.504	(0.000)	-0.542	(0.000)	-0.458	(0.000)			-0.030	(0.813)
$DLTB_{(-2)}$	-0.290	(0.018)							-0.285	(0.021)			0.434	(0.000)
$DLTB_{(-3)}$	-0.521	(0.000)							-0.521	(0.000)				
DLY	-2.882	(0.429)	-2.201	(0.218)	-0.129	(0.226)	0.120	(0.132)	-2.770	(0.441)	-5.619	(0.134)	-2.908	(0.180)
$DLY_{(-1)}$							0.164	(0.056)						
$DLY_{(-2)}$							0.298	(0.001)						
$DLY_{(-3)}$							0.266	(0.001)						
DLYROW	7.690	(0.016)	1.475	(0.316)	0.348	(0.019)	0.073	(0.460)	7.525	(0.017)	8.058	(0.012)	9.925	(0.002)
$DLYROW_{(-1)}$					-0.400	(0.016)	-0.552	(0.000)					-5.917	(0.063)
$DLYROW_{(-2)}$					0.082	(0.612)	-0.343	(0.003)					-0.703	(0.812)
$DLYROW_{(-3)}$					0.239	(0.167)							5.541	(0.010)
$DLYROW_{(-4)}$					0.064	(0.682)								
$DLYROW_{(-5)}$					0.212	(0.069)								
$DLREER^{+}$	-3.603	(0.007)	-0.286	(0.665)	-0.089	(0.011)	-0.126	(0.000)	-3.517	(0.007)	-2.530	(0.070)	-1.732	(0.020)
$DLREER^{+}_{(-1)}$													2.627	(0.005)
$DLREER^{+}_{(-2)}$													2.460	(0.006)
$DLREER^{+}_{(-3)}$													2.733	(0.002)
$DLREER^{-}$	0.456	(0.563)	0.988	(0.023)	0.060	(0.015)	0.061	(0.001)	0.399	(0.607)	1.380	(0.099)	0.805	(0.096)
$DLREER^{-}_{(-1)}$			-1.008	(0.007)	0.072	(0.011)	0.042	(0.007)					-1.128	(0.032)
$DLREER^{-}_{(-2)}$					-0.009	(0.707)	0.005	(0.712)					-1.175	(0.041)
$DLREER^{-}_{(-3)}$					-0.025	(0.297)	-0.070	(0.000)					-1.024	(0.053)
DLMBASE	-1.112	(0.172)	0.899	(0.023)	0.058	(0.029)	0.019	(0.204)	-1.134	(0.157)	0.057	(0.947)	-0.497	(0.300)
$DLMBASE_{(-1)}$					0.100	(0.003)	0.036	(0.016)						
$DLMBASE_{(-2)}$					0.061	(0.040)								
$DLMBASE_{(-3)}$					0.072	(0.013)								
$DLMBASE_{(-4)}$					0.050	(0.042)								
Constant	6.386	(0.912)	-22.265	(0.057)	4.044	(0.009)	1.758	(0.131)	4.059	(0.943)	-68.474	(0.006)	-49.467	(0.042)
LY	-5.217	(0.095)	-1.949	(0.019)	-0.193	(0.020)	-0.154	(0.068)	-4.977	(0.114)	-11.014	(0.000)	-3.646	(0.012)

LYROW	8.485	(0.013)	1.748	(0.045)	0.023	(0.820)	0.010	(0.915)	8.318	(0.014)	10.631	(0.000)	7.639	(0.000)
$LREER^+$	-0.967	(0.638)	-0.205	(0.681)	0.122	(0.023)	0.039	(0.401)	-1.158	(0.567)	-2.436	(0.032)	-2.377	(0.026)
$LREER^-$	0.736	(0.613)	0.753	(0.011)	-0.038	(0.311)	0.003	(0.915)	0.655	(0.655)	3.049	(0.000)	1.375	(0.013)
LMBASE	-2.614	(0.231)	0.717	(0.016)	-0.053	(0.115)	0.020	(0.476)	-2.547	(0.241)	1.686	(0.007)	-0.868	(0.146)
DUM			2017Q2		2018Q3		2006Q3, 2018Q1, 2018Q3							
ECT	-0.410	(0.000)	-0.923	(0.000)	-0.660	(0.000)	-0.477	(0.000)	-0.403	(0.000)	-0.747	(0.000)	-0.708	(0.000)
R^2 adj	0.659		0.401		0.465		0.730		0.672		0.299		0.663	
F-test	4.371		6.840		2.169		6.087		4.244		5.057		4.197	
J-B	2.244	(0.326)	0.802	(0.670)	4.731	(0.094)	0.746	(0.689)	1.909	(0.385)	1.654	(0.437)	3.974	(0.137)
LM (F)	0.912	(0.409)	1.387	(0.260)	1.593	(0.222)	4.076	(0.028)	0.910	(0.410)	1.148	(0.326)	1.037	(0.366)
LM	2.228	(0.328)	3.310	(0.191)	5.701	(0.058)	12.403	(0.002)	2.225	(0.329)	2.590	(0.274)	3.348	(0.188)
Heterosk.	4.934	(0.840)	13.648	(0.135)	30.212	(0.178)	21.324	(0.620)	4.766	(0.854)	5.042	(0.539)	11.020	(0.946)
RESET	0.855	(0.397)	0.260	(0.796)	0.240	(0.812)	2.122	(0.043)	0.886	(0.381)	0.937	(0.353)	0.271	(0.788)
Wald LR	4.734	(0.030)	0.773	(0.379)	0.552	(0.458)	0.536	(0.464)	1.318	(0.251)	16.364	(0.000)	0.874	(0.350)
CUSUM	S		S		S		S		S		S		S	
CUSUMSQ	S		S		US		S		S		S		S	

Note. As per Table 3.

Conclusion

The paper concerned empirical testing of the J-curve effect and Marshall-Lerner condition, the former assuming short-run deterioration of the trade balance following depreciation of the currency, the latter hypothesizing the long-term improvement of the trade balance following temporary deterioration. The topic has been examined empirically in a number of contexts, using a variety of methods. This paper attempted to verify the presence of J-curve and Marshall-Lerner condition in the services trade of the UK with the rest of the world during the 2005Q1-2019Q4 period, using aggregate as well as disaggregated (transport, travel, goods-related, commercial, and other services categories) data. The variables used in the analysis included domestic and 'rest of the world' GDP, domestic monetary base, as well as two alternative versions of the real effective exchange rate, based on consumer price index or the unit labour costs. Given the mixed order of integration of the variables and possibility of the rejection of the hypotheses as a result of linearity assumptions embedded in the model, the use of linear as well as non-linear (asymmetric) autoregressive distributed lag (ARDL) models were determined to be an appropriate empirical analysis tool.

The support of both hypotheses was minimal: across a total of 25 models that were estimated (linear and non-linear, with alternative REER measures), the long-run improvement of the trade balance following depreciation was observed only in two cases. The patterns that contravene J-curve hypothesis, such as balance deterioration in short- and long-run, as well as short-run improvement followed by a long-run deterioration, were also observed, respectively in seven and six models. The effects of domestic and 'rest of the world' GDP on the trade balance were, in most instances, negative and positive, while the influence of the monetary base was mixed. In terms of significance of the variables, the domestic and 'rest of the world' GDP were significance in 21 models out of 25, while REER and monetary base were significant in only 13 models out of 25. Thus, based on a partial equilibrium framework adopted in this paper, the policies that target output levels (e.g. fiscal policy) as opposed to exchange rate or monetary policies are likely to be more effective in correcting external imbalances.

According to Wijeweera and Dollery (2013), the J-curve effect is likely to be more pronounced in the services sector, given that exports and imports of services tend to adjust slower to depreciation than trade in manufactured goods. The findings in this paper, however, give support to alternative explanations of the relationship between exchange rate and trade balance in the services trade and of the absence of the J-curve and Marshall-Lerner condition. Firstly, it may be argued that quality of services and the presence of activities that are adjacent to the services are the driving factor of the demand (and accordingly the exports and imports) of services, rather than the level of exchange rate and the relative prices. Secondly, the degree of import content of services exports from the UK may be substantial (the topic that awaits separate study). Hence, depreciation of pound and the ensuing increase in the prices of imports may increase the costs of exported services, increase export prices and stymie growth of export volume, contra to J-curve proposition (Yazici, Klarsa, 2010: 769). Thirdly, the prices for certain categories of services, e.g. travel and tourism services, may be set in foreign currency (e.g. US dollars or Euro, as opposed to Pounds), and hence fluctuations of the exchange rate would have little or no effect on the value or volume of exports (Prakash and Maiti, 2016: 387). Fourthly, international trade in a number of services (such as insurance or intellectual property) is underpinned by the long-term contractual obligations and is less sensitive to exchange rate changes (Chang, 2020).

As a concluding remark we note that identification of the J-curve and verification of the Marshall-Lerner condition is principally an empirical issue, determined by contextual, country- and service-specific factors. Some of the services categories examined in this paper aggregate services that are different from each other in terms of sensitivity to exchange rate, import content of exports and other respects (e.g. 'other services' that include construction, insurance, telecommunications, among others), hence for the sake of getting more reliable results, the future research may require a higher degree of disaggregation.

References

Akbostanci, E. (2004), Dynamics of Trade Balance: The Turkish J-Curve, *Emerging Markets Finance and Trade*, 40 (5), 57-73.

Akoto, L. and Sakyi, D. (2019), Empirical Analysis of the Determinants of Trade Balance in Post-Liberalization Ghana, *Foreign Trade Review*, 54 (3), 177-205.

Arize, A. (1987), The Supply and Demand for Imports and Exports in a Simultaneous Model, *Applied Economics*, 19 (9), 1233-1247.

Bahmani-Oskooee, M. (1985), Devaluation and the J-Curve: Some Evidence from LDCs, *The Review of Economics and Statistics*, 67 (3), 500-504.

Bahmani-Oskooee, M. and Ratha, A. (2004a), ARDL Approach to Test the Productivity Bias Hypothesis, *Review of Development Economics*, 8 (3), 483-488.

Bahmani-Oskooee, M. and Ratha, A. (2004b), The J-Curve Dynamics of US Bilateral Trade, *Journal of Economics and Finance*, 28 (1), 32-38.

Bahmani-Oskooee, M. and Ratha, A. (2004c), The J-Curve: A Literature Review, *Applied Economics*, 36 (13), 1377-1398.

Bahmani-Oskooee, M., Halicioglu, F. and Ghodsi, S. (2016), Asymmetric Effects of Exchange Rate Changes on British Bilateral Trade Balances, MPRA Paper No. 73477.

Bahmani-Oskooee, M. and Harvey, H. (2017), The Asymmetric Effects of Exchange Rate Changes on the Trade Balance of Singapore, *Global Economy Journal*, 17 (4), 1-11.

Bahmani-Oskooee, M., Iqbal, J. and Muzammil, M. (2017), Pakistan-EU Commodity Trade: Is There Evidence of J-Curve Effect? *Global Economy Journal*, 17 (2), 1-8.

Bahmani-Oskooee, M., Bose, N. and Zhang, Y. (2018), Asymmetric Cointegration, Nonlinear ARDL, and the J-Curve: A Bilateral Analysis of China and its 21 Trading Partners, *Emerging Markets Finance and Trade*, 54 (13), 3131-3151.

Banerjee, A., Dolado, J. and Mestre, R. (1998), Error-Correction Mechanism Tests for Cointegration in a Single-Equation Framework, *Journal of Time Series Analysis*, 19 (3), 267-284.

Barras, R. (1986), Towards a Theory of Innovation in Services, *Research Policy*, 15 (4), 161-173.

Baumol, W., Blackman, S. and Wolff, E. (1985), Unbalanced Growth Revisited: Asymptotic Stagnancy and New Evidence, *American Economic Review*, 75 (4), 806-817.

Brada, J. C., Kutan, A. M. and Zhou, S. (1997), The Exchange Rate and the Balance of Trade: The Turkish Experience, *Journal of Development Studies*, 33 (5), 675-692.

Chenery, H. (1960), Patterns of Industrial Growth, *American Economic Review*, 50 (4), 624-654.

Cheng, K. M. (2020), Currency Devaluation and Trade Balance: Evidence from the US Services Trade, *Journal of Policy Modeling*, 42 (1), 20-37.

Costamagna, R. (2014), Competitive Devaluations and the Trade Balance in Less Developed Countries: An Empirical Study of Latin American Countries, *Economic Analysis and Policy*, 44 (4), 266-278.

Demirden, T. and Pastine, I. (1995), Flexible Exchange Rates and the J-curve: An Alternative Approach, *Economics Letters*, 48 (3-4), 373-377.

Dickey, D. A. and Fuller, W. A. (1981), Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica*, 49 (4), 1057-1072.

Doytch, N. and Uctum, M. (2011), Does the Worldwide Shift of FDI from Manufacturing to Services Accelerate Economic Growth? A GMM Estimation Study, *Journal of International Money and Finance*, 30 (3), 410-427.

Flemingham, B. S. (1988), Where is the Australian J-Curve? *Bulletin of Economic Research*, 40 (1), 43-56.

Guptar-Kapoor, A. and Ramakrishnan, U. (1999), Is There a J-Curve: A New Estimation for Japan, *International Economic Journal*, 13 (4), 71-79.

Gürtler, M. (2019), Dynamic Analysis of Trade Balance Behavior in a Small Open Economy: The J-Curve Phenomenon and the Czech Economy. *Empirical Economics*, 56 (2), 469-497.

Hacker, R. and Hatemi-J, A. (2003), Is the J-Curve Effect Observable for Small North European Economies? *Open Economies Review*, 14 (2), 119-134.

Hatemi-J, A. and Irandoust, M. (2005), Bilateral Trade Elasticities: Sweden versus her Trade Partners, *American Journal of Political Economy*, 3 (2), 38-50.

Haug, A. (2002), Temporal Aggregation and the Power of Cointegration Tests: A Monte Carlo Study, *Oxford Bulletin of Economics and Statistics*, 64 (4), 399-412.

Hsing, Y. (2010), Test of the Marshall-Lerner Condition for Eight Selected Asian Countries and Policy Implications, G*lobal Economic Review: Perspectives on East Asian Economies and Industries*, 39 (1), 91-98.

International Monetary Fund, IMF (2009), Balance of Payments and International Investment Position Manual, 6th Edition (BPM6), Washington, D.C.: International Monetary Fund.

Iqbal, J., Nosheen, M. and Panezai, G. (2021, forthcoming), Asymmetric Cointegration, Non-linear ARDL, and the J-Curve: A Bilateral Analysis of Pakistan and its Trading Partners, *International Journal of Finance and Economics*.

Jamilov, R. (2013), J-Curve Dynamics and the Marshall-Lerner Condition: Evidence from Azerbaijan, *Transition Studies Review*, 19 (3), 313-323.

Jozepa, I., Ward, M. and Harari, D. (2019), Trade in Services and Brexit, House of Commons Library Briefing Paper No. 8586.

Karadeloglou, P. (1990), On the Existence of an Inverse J-curve, *Greek Economic Review*, 12 (2), 285-305.

Kim, Y.-Y. (2012), Dynamic Analysis of Trade Balance and Real Exchange Rate: A Stationary VAR Form of Error Correction Model Approach, *Seoul Journal of Economics*, 25 (3), 317-337.

Kremers, J., Ericson, N. and Dolado, J. (1992), The Power of Cointegration Tests, *Oxford Bulletin of Economics and Statistics*, 54 (3), 325-348.

Kwiatkowski, D., Phillips, P., Schmidt, P. and Shin, Y. (1992), Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root, *Journal of Econometrics*, 54 (1-3), 159-178.

Lal, A. K. and Lowinger, T. C. (2002), The J-Curve: Evidence from East Asia, *Journal of Economic Integration*, 17 (2), 397-415.

Lee, J. and Strazicich, M. (2003), Minimum LM Unit Root Test with Two Structural Breaks, *Review of Economics and Statistics*, 85 (4), 1082-1089.

Lee, J. and Strazicich, M. (2004), Minimum LM Unit Root Test with One Structural Break, Appalachian State University, Department of Economics Working Paper No. 04 (19).

Magee, S. P. (1973), Currency Contracts, Pass-Through, and Devaluation, *Brookings Papers on Economic Activity*, 1, 303-325.

Mahmud, S., Ullah, A. and Yucel, E. (2004), Testing Marshall-Lerner Condition: A Non-Parametric Approach, *Applied Economics Letters*, 11 (4), 231-236.

McDaniel, C. A. and Agama, L.-A. (2003), The NAFTA Preference and US-Mexico Trade: Aggregate-Level Analysis, *World Economy*, 26 (7), 939-955.

Miles, M. (1979), The Effects of Devaluation on the Trade Balance and the Balance of Payments: Some New Results, *Journal of Political Economy*, 87 (3), 600-620.

Narayan, P. K. (2006), Examining the Relationship between Trade Balance and Exchange Rate: The Case of China's Trade with the US, *Applied Economics Letters*, 13 (8), 507-510.

Nelson, C. and Plosser, P. (1982), Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications, *Journal of Monetary Economics*, 10 (2), 139-162.

Nusair, S. (2017), The J-Curve Phenomenon in European Transition Economies: A Nonlinear ARDL Approach, International Review of Applied Economics, 31 (1), 1-27.

Parikh, A. and Shibata, M. (2004), Dynamics of the Relationship between the Terms of Trade and the Trade Balance in Developing Countries of Asia, Africa, and Latin America, *Journal of Quantitative Economics*, 2 (2), 104-121.

Pazinetti, L. (1993), *Structural Economic Dynamics*, Cambridge: Cambridge University Press.

Perron, P. (1989), The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis, *Econometrica*, 57 (6), 1361-1401.

Pesaran, M. H. and Shin, Y. (1999), An Autoregressive Distributed Lag Modeling Approach to Co-integration Analysis, in Strom, S. (ed.) *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, Cambridge: Cambridge University Press.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001), Bounds Testing Approaches to the Analysis of Level Relationships, *Journal of Applied Econometrics*, 16 (3), 289-326.

Prakash, K. and Maiti, D. (2016), Does Devaluation Improve Trade Balance in Small Island Economies? The Case of Fiji, *Economic Modelling*, 55 (C), 382-393.

Rose, A. K. and Yellen, J. L. (1989), Is There a J-Curve? *Journal of Monetary Economics*, 24 (1), 53-68.

Senhadji, A. S. (1998), Dynamics of the Trade Balance and the Terms of Trade in LDCs: The S-Curve, *Journal of International Economics*, 46 (1), 105-131.

Shin, Y., Yu, B. and Greenwood-Nimmo, M. (2013), Modelling Asymmetric Co-integration and Dynamic Multipliers in a Nonlinear ARDL Framework, in Sickels, R. and Horrace, W. (eds.) *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*. New York: Springer, 281-314.

Sivrikaya, A. and Ongan, S. (2019), BREXIT and the J-Curve Hypothesis for the UK: A Nonlinear ARDL Approach, *Sosyoekonomi Journal*, 27 (40), 229-239.

Tether, B. S. (2003), The Sources and Aims of Innovation in Services: Variety Between and Within Sectors, *Economics of Innovation and New Technology*, 12 (6), 481-505.

Yazici, M. (2006), Is the J-Curve Effect Observable in Turkish Agricultural Sector? *Journal of Central European Agriculture*, 7 (2), 319-322.

Yazici, M. (2010), Is There a J-curve Effect in Turkish Services? *Quality and Quantity: International Journal of Methodology*, 44 (1), 167-172.

Yazici, M. and Klarsa, M. (2010), Import-content of Exports and J-curve Effect, *Applied Economics*, 42, 769-776.

Waliullah, M., Kakar, R. and Khan, W. (2010), The Determinants of Pakistan’s Trade Balance: An ARDL Cointegration Approach, *The Lahore Journal of Economic*s, 15 (1), 1-26.

Wijeweera, A. and Dollery, B. (2013), J-curve Disparity between the Goods Sector and the Services Sector: Evidence from Australia, *Applied Economics Letters*, 20 (5), 452-456.

Zanello, A. and Desruelle, D. (1997), A Primer on the IMF’s Information Notice System, IMF Working Paper No. WP/97/71, 1-33.

Zivot, E. and Andrews, D. (1992), Further Evidence on the Great Crash, the Oil Price Shock, and the Unit Root Hypothesis, *Journal of Business and Economic Statistics*, 10 (3), 251-270.