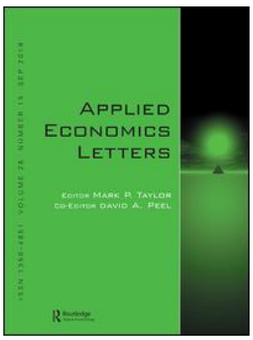

Routledge
Taylor & Francis Group

Applied Economics Letters

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rael20

# Testing the balance of payments constrained growth model in a VECM framework: the cases of Brazil, Korea, Mexico and Turkey

Ayse Ozden Birkan

**To cite this article:** Ayse Ozden Birkan (2021): Testing the balance of payments constrained growth model in a VECM framework: the cases of Brazil, Korea, Mexico and Turkey, Applied Economics Letters, DOI: 10.1080/13504851.2021.1937487

**To link to this article:** https://doi.org/10.1080/13504851.2021.1937487

Published online: 15 Jun 2021.

Submit your article to this journal

Article views: 85

View related articles

View Crossmark data

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=rael20

APPLIED ECONOMICS LETTERS
https://doi.org/10.1080/13504851.2021.1937487

Routledge
Taylor & Francis Group

Check for updates

# Testing the balance of payments constrained growth model in a VECM framework: the cases of Brazil, Korea, Mexico and Turkey

Ayse Ozden Birkan

Yaşar University, Izmir, Turkey

**ABSTRACT**

The aim of this study is to explore the empirical application of a previously unexplored procedure to systematically estimate and test the tenets of the balance of payments constrained growth (BOPCG) the model within a VECM framework. The three structural equations that constitute the BOPCG model are estimated as long run equilibrium relations using the Johansen cointegration analysis technique for Brazil, Korea, Mexico and Turkey over the 1980–2016 period. The BOPCG hypothesis is then tested in terms of non-linear coefficient restrictions on the cointegrating vectors. Hypotheses on the exogeneity of real exchange rate and the world income are also tested in terms of tests on the adjustment coefficients. Results provide evidence in favour of Thirlwall's Law for the cases of Brazil and Korea.

**KEYWORDS**

Balance of payments constrained growth; thirlwall's law; vector error correction model; non-linear restrictions on cointegrating vectors

## I. Introduction

The balance of payments constrained growth (BOPCG) model has developed into a large body of theoretical and empirical literature since its initial presentation by Thirlwall (1979). Thirlwall (2011), McCombie (2011) and Setterfield (2011) present a comprehensive theoretical overview of the development of the idea and the consequent critiques, while McCombie (1997) discusses the literature on the empirical testing of the hypothesis.

The basic model expressed in log-levels, ignoring capital mobility, consists of the following three equations:

Demand for exports:

$$x = x_0 + \varepsilon y_f + \eta z,\ \ \eta < 0,\ \ \varepsilon > 0 \tag{1}$$

Demand for imports:

$$m = m_0 + \pi y + \psi z,\ \ \psi > 0,\ \ \pi > 0 \tag{2}$$

Balance of Payments:

$$p_d + x = p_f + e + m \tag{3}$$

where; $x$ : natural logarithm of the quantity of exports, $m$ : natural logarithm of the quantity of imports, $y$ : natural logarithm of the domestic income, $y_f$ : natural logarithm of the world income, $\pi$ : income elasticity of imports, $\psi$ : real exchange rate elasticity of imports, $\varepsilon$ : income elasticity of exports, $\eta$ : real exchange rate elasticity of exports, and $z = p_d - p_f - e$, natural logarithm of the price of domestic goods in terms of foreign goods, or equivalently the real exchange rate.

Solving for domestic income, $y$, gives:

$$y_B = \frac{(x_0 - m_0)}{\pi} + \frac{\varepsilon}{\pi} y_f + \frac{(1 + \eta - \psi)}{\pi} z \tag{4}$$

If, following the literature convention, foreign income is assumed to be exogenous, autonomous exports and imports are assumed away, ($x_0 = 0$ and $m_0 = 0$) and it is assumed that the Marshal-Lerner condition is just satisfied ($(1 + \eta - \psi) = 0$) or that the purchasing power parity holds so that the real exchange rate is constant, ($z = 0$), equation (4) reduces to:

$$y_B = \frac{\varepsilon}{\pi} y_f \tag{5}$$

Differentiating this with respect to time yields the original Thirwall's Law, which claims that the long run equilibrium growth rate of a country is determined by the world income growth rate and the ratio of the income elasticities of the demand for exports and imports.

**CONTACT** Ayse Ozden Birkan ozden.birkan@yasar.edu.tr Yaşar University, Izmir, Turkey

© 2021 Informa UK Limited, trading as Taylor & Francis Group

After decades of empirical and theoretical discussions on Thirwall's Law, it is still interesting to analyse and estimate this model because its basic premises of demand-led growth and the overriding significance of international trade in creating such demand-led growth have only been further highlighted in the context of globalization, especially for developing countries. Moreover, another fundamental implication of Thirwall's Law, that is the fact that in the long run no country can grow faster than the rate consistent with balance of payment equilibrium because it cannot finance ever-growing trade deficits has also been empirically verified by the experiences of many countries that had crises due to capital reversals countless times. In addition to the empirical relevance of the model, from a theoretical perspective it provides a solid analytical backbone to coherently bring together many threads of discussion on trade, technology, international financial flows, growth and development and offers concrete policy advice. That is one of the reasons it has kept its appeal as an analytical tool over so many decades.

The aim of this study is to investigate if the use of a previously unexplored econometric framework provides support for the empirical results of this vast literature. Kvedaras (2007) provides a new contribution to the literature on the empirical estimation and testing of the BOPCG model. The next section outlines the method proposed, followed by a section which presents the application of the method to a selection of four countries, namely Brazil, Korea, Mexico and Turkey over the 1980–2016 period. Final remarks follow.

## II. Methodology

As presented in detail in Kvedaras (2007), if $y$, $x$, $m$, $z$, $y_w$ are unit root processes, the BOPCG model can be formulated as a VECM of the form:

$$\Delta W_t = c + \alpha\beta' W_t + \varphi(L)\Delta W_t + u_t$$

where C is a vector of constants, $W$ is a $5 \times 1$ vector of variables with $W' = \left(y, x, m, z, y_f\right)$, $\varphi(L)$ is an appropriate polynomial of lags and $u$ is a vector of white noise errors. $\alpha$ and $\beta$ are matrices for the equilibrium adjustment coefficients and the cointegrating vectors, respectively.

If the BOPCG hypothesis empirically holds, this system should have at least three cointegrating vectors, corresponding to export, import and BOP equations given in equations (1), (2) and (4) or (5), respectively.

After just identifying the cointegrating vectors as the export demand, import demand and BOP equations, the following overidentifying restrictions on the cointegrating vectors and the adjustment coefficients are considered:

$H_1 : b_{BOP4} = -\frac{(1+\eta-\psi)}{\pi} and b_{BOP5} = -\frac{\varepsilon}{\pi}$ corresponds to testing if the BOPCG hypothesis holds in the form of equation (4).[1]

$H_2 : b_{BOP4} = 0 and b_{BOP5} = -\frac{\varepsilon}{\pi}$ corresponds to testing Thirlwall's Law.

$H_3 : b_{x4} = b_{m4} = 0$ corresponds to testing if the real exchange rate enters the long run import and export functions.[2]

$H_4 : a_{51} = a_{52} = a_{53} = 0$ corresponds to testing the weak exogeneity of world income with respect to the cointegrating vectors.[3]

$H_5 : a_{41} = a_{42} = a_{43} = 0$ corresponds to testing the weak exogeneity of the real exchange rate with respect to the cointegrating vectors.[4]

## III. Data and estimation results

The above VECM model is estimated for four countries, namely Brazil, Korea, Mexico and Turkey using annual series over the 1980–2016 period. This period represents a coherent time span in terms of growing international trade flows for developing countries as well as deliberate export promotion strategies. However, albeit sufficient, a sample of 36 years does fall on the shorter end of the spectrum for long-run analysis. It should be acknowledged that the power of cointegration tests depends on the time span. This is somewhat reflected in the fact that out of the many countries considered in our preliminary analysis, only these four satisfied the required time series properties in terms of the order of integration and the number of

[1]These are the coefficients of the real exchange rate and the world income in the BOP cointegrating vector.
[2]These are the coefficients of the real exchange rate in the export and import cointegrating vectors.
[3]These are the adjustment coefficients of the three cointegrating vectors in the $\Delta y_w$ equation.
[4]These are the adjustment coefficients of the three cointegrating vectors in the $\Delta z$ equation.

cointegrating vectors. Fortunately, these countries constitute a coherent set on the basis of the fact that they are frequently cited as strong export promoters where the BOPCG hypothesis is expected to hold. World income is approximated by USA real GDP series. Data definitions and sources are presented in Table 1. All series are in natural logarithms.

Table 2 presents enough evidence to declare all the series I (1). The longest unrestricted VAR that can be estimated and tested with the available data for any of the four countries is a VAR (4). Lag exclusion tests for each country's model are presented in Table 3. In accordance with these results a VAR (3) for Brazil, a VAR (2) for Korea, a VAR (4) for Mexico and a VAR (4) for Turkey are estimated. The unrestricted VARs are of no interest so they are not reported. Suffice it to note that vector normality tests were passed.

The Johansen (1995) trace and maximum eigenvalue tests for cointegration rank are reported in Table 4. Maximum eigenvalue tests suggest the models have three cointegrating vectors each, as required. The just identified cointegrating vectors and respective adjustment coefficients are presented in Table 5. It should be noted that only the Brazilian case is consistent with the theoretical sign requirements. Test results for the hypotheses considered are given in Table 6.

For Brazil, at the 99% level $H_2$ and $H_5$ are not rejected while all the other hypotheses are rejected which suggests that the sample provides support for the original Thirlwall's Law and the long-run weak exogeneity of the real exchange rate over the sample period.

For South Korea, at the 99% level,, $H_3$ and $H_2H_3$ as well as $H_4$ are not rejected while all the other hypotheses are rejected which suggests the real exchange rate does not enter the long run import and export functions and the original Thirlwall's Law holds. Data also supports the weak exogeneity of world income.

For Mexico, all hypotheses are rejected at conventional significance levels except for $H_3$, which

**Table 1.** Data definitions and sources.

| Variable | Definition | Source |
|---|---|---|
| x | the export volume index, 2010 = 100 | WDI |
| m | the import volume index, 2010 = 100 | WDI |
| z | the real effective exchange rate index, 2010 = 100 | WDI, CBRT (for Turkey), BIS (for Korea) |
| y | domestic country real GDP index, 2010 = 100 | WDI (series transformed into an index) |
| _br | variable subscript for Brazil | |
| _ko | variable subscript for Korea | |
| _me | variable subscript for Mexico | |
| _tr | variable subscript for Turkey | |
| _us | variable subscript for USA | |

**Table 2.** Unit root tests.

| Brazil | | | Korea | | | USA | |
|---|---|---|---|---|---|---|---|
| | ADF | KPSS | | ADF | KPSS | ADF | KPSS |
| ybr | −0.25 | 0.71 | yko (*) | −0.67 | 0.19 | yus −1.64 | 0.72 |
| Δybr | −4.26 | 0.10 | Δyko | −6.26 | 0.25 | Δyus −3.99 | 0.35 |
| xbr | −0.77 | 0.72 | xko | −1.87 | 0.72 | Note: The 90% critical values for the ADF and the KPSS tests are −2.61 and 0.35, respectively. (*) indicates the | |
| Δxbr | −5.79 | 0.14 | Δxko | −4.65 | 0.35 | presence of an intercept and a trend in the test equation, whereby the critical values become −3.20 and 0.12, | |
| mbr | −0.46 | 0.67 | mko | −2.04 | 0.71 | respectively. | |
| Δmbr | −4.42 | 0.12 | Δmko | −5.94 | 0.53 | | |
| zbr | −2.23 | 0.13 | zko | −3.49 | 0.41 | | |
| Δzbr | −5.21 | 0.05 | Δzko | −5.33 | 0.30 | | |
| Mexico | | | Turkey | | | | |
| | ADF | KPSS | | ADF | KPSS | | |
| yme | −0.08 | 0.72 | ytr | 0.00 | 0.73 | | |
| Δyme | −6.52 | 0.14 | Δytr | −6.31 | 0.09 | | |
| xme (*) | −1.33 | 0.19 | xtr | −1.25 | 0.71 | | |
| Δxme | −4.37 | 0.09 | Δxtr | −7.26 | 0.32 | | |
| mme | −0.42 | 0.67 | mtr | −0.73 | 0.69 | | |
| Δmme | −4.97 | 0.12 | Δmtr | −6.14 | 0.12 | | |
| zme | −2.96 | 0.14 | ztr | −1.17 | 0.48 | | |
| Δzme | −5.59 | 0.17 | Δztr | −7.63 | 0.10 | | |

**Table 3.** VAR lag exclusion Wald tests (p-values in parantheses).

| Lag Exclusion Tests | | | | |
|---|---|---|---|---|
| | VAR(4) | VAR(3) | VAR(2) | VAR(1) |
| Brazil | | | | |
| Lag 1 | 84.09 (0.00) | 154.31 (0.00) | 269.41 (0.00) | 11,724.45 (0.00) |
| Lag 2 | 35.83 (0.07) | 23.62 (0.54) | 47.98 (0.00) | |
| Lag 3 | 23.79 (0.53) | 51.64 (0.00) | | |
| Lag 4 | 36.80 (0.06) | | | |
| Mexico | | | | |
| Lag 1 | 162.83 (0.00) | 122.54 (0.00) | 150.45 (0.00) | 17,737.38 (0.00) |
| Lag 2 | 66.38 (0.00) | 56.92 (0.00) | 40.46 (0.03) | |
| Lag 3 | 38.65 (0.04) | 52.24 (0.00) | | |
| Lag 4 | 104.34 (0.00) | | | |
| Korea | | | | |
| Lag 1 | 63.58 (0.00) | 126.81 (0.00) | 185.45 (0.00) | 63044.34 (0.00) |
| Lag 2 | 17.74 (0.00) | 15.33 (0.00) | 40.39 (0.00) | |
| Lag 3 | 13.95 (0.00) | 26.77 (0.00) | | |
| Lag 4 | 22.21 (0.00) | | | |
| Turkey | | | | |
| Lag 1 | 76.25 (0.00) | 248.78 (0.00) | 149.15 (0.00) | 18,111.73 (0.00) |
| Lag 2 | 57.11 (0.00) | 54.95 (0.00) | 38.59 (0.00) | |
| Lag 3 | 67.61 (0.00) | 78.73 (0.00) | | |
| Lag 4 | 55.58 (0.00) | | | |

could not be tested due to lack of convergence in the estimation of the underlying likelihood functions.

For Turkey, only $H_4$ is not rejected which suggests world income is weakly exogenous with respect to the Turkish external sector. $H_1$ and $H_5$ could not be tested due to lack of convergence.

Countrywise empirical results on the validity of the BOPCG hypothesis are mixed and sensitive to the choice of time horizon and econometric technique. For Brazil, the sample used here comes close to Nassif, Feijó, and Araújo (2015) which covers the 1980–2010 period. These findings are consistent with theirs in terms of representing the inability of Brazil to keep the income elasticity of the demand for imports below the income elasticity of the demand for exports and, as a result, sustaining a binding BOP constraint. Nassif, Feijó, and Araújo (2015) also point out that the constraint has been tightening due to a widening technological gap and premature deindustrialization in Brazil. With regard to South Korea, Darku (2019) analyzes the 1960–2016 period and concludes that BOP constraint has been binding for Korea since the major determinants of income growth in South Korea are exports, capital inflows, and real exchange rates. Our findings are consistent with his in terms of the role of exports, but we find no support for the role of the real exchange rate, while capital flows are not part of our discussion. Brazil,

**Table 4.** Johansen cointegration tests (p-values in parantheses).

| Johansen (1995) Cointegration Tests | | | | | | | |
|---|---|---|---|---|---|---|---|
| Brazil | | | | Korea | | | |
| Null | Eigenvalue | Trace | Maximum Eigenvalue | Null Hypothesis | Eigenvalue | Trace | Maximum Eigenvalue |
| r ≤ 0 | 0.78 | 120.09 (0.00) | 51.48 (0.00) | r ≤ 0 | 0.70 | 103.84 (0.00) | 41.60 (0.00) |
| r ≤ 1 | 0.61 | 68.62 (0.00) | 31.63 (0.01) | r ≤ 1 | 0.54 | 62.24 (0.00) | 27.00 (0.06) |
| r ≤ 2 | 0.48 | 36.99 (0.01) | 21.98 (0.04) | r ≤ 2 | 0.41 | 35.25 (0.01) | 18.70 (0.11) |
| r ≤ 3 | 0.24 | 15.01 (0.06) | 9.20 (0.27) | r ≤ 3 | 0.25 | 16.54 (0.03) | 10.19 (0.20) |
| r ≤ 4 | 0.16 | 5.81 (0.02) | 5.81 (0.02) | r ≤ 4 | 0.17 | 6.35 (0.01) | 6.35 (0.01) |
| Mexico | | | | Turkey | | | |
| Null Hypothesis | Eigenvalue | Trace | Maximum Eigenvalue | Null Hypothesis | Eigenvalue | Trace | Maximum Eigenvalue |
| r ≤ 0 | 0.93 | 177.04 (0.00) | 90.19 (0.00) | r ≤ 0 | 0.80 | 130.70 (0.00) | 53.75 (0.00) |
| r ≤ 1 | 0.74 | 86.86 (0.00) | 44.74 (0.00) | r ≤ 1 | 0.69 | 76.95 (0.00) | 38.43 (0.00) |
| r ≤ 2 | 0.61 | 42.11 (0.00) | 31.09 (0.00) | r ≤ 2 | 0.53 | 38.52 (0.00) | 25.29 (0.01) |
| r ≤ 3 | 0.27 | 11.03 (0.21) | 10.56 (0.18) | r ≤ 3 | 0.31 | 13.23 (0.11) | 12.06 (0.11) |
| r ≤ 4 | 0.01 | 0.46 (0.50) | 0.46 (0.50) | r ≤ 4 | 0.03 | 1.17 (0.28) | 1.17 (0.28) |

**Table 5.** Just identified cointegrating vectors and equilibrium adjustment coefficients (standard errors in parantheses).

| Brazil | | | | | | | Korea | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\beta_x$ | $\beta_m$ | $\beta_{BOP}$ | $\alpha_x$ | $\alpha_m$ | $\alpha_{BOP}$ | | $\beta_x$ | $\beta_m$ | $\beta_{BOP}$ | $\alpha_x$ | $\alpha_m$ | $\alpha_{BOP}$ |
| ybr | 0 | −2.85 (0.40) | 1 | 0.11 (0.03) | −0.02 (0.02) | −0.43 (0.11) | yko | 0 | −1.20 (0.04) | 1 | −0.03 (0.01) | −0.29 (0.10) | −0.11 80.03) |
| xbr | 1 | 0 | 0 | −0.01 (0.07) | 0.17 (0.06) | 0.41 (0.28) | xko | 1 | 0 | 0 | 0.04 (0.03) | 0.15 (0.26) | 0.05 (0.08) |
| mbr | 0 | 1 | 0 | 0.25 (0.19) | −0.21 (0.15) | −1.77 (0.75) | mko | 0 | 1 | 0 | −0.07 (0.04) | −1.25 (0.31) | −0.007 (0.10) |
| zbr | 4.00 (0.70) | −4.75 (0.95) | 0.90 (0.24) | −0.28 (0.16) | −0.10 (0.13) | 0.23 (0.64) | zko | −7.35 (1.63) | 0.42 (0.17) | 1.56 (0.41) | 0.05 (0.04) | −0.54 (0.31) | 0.07 (0.10) |
| yus | −2.74 (0.29) | 0 | −1.09 (0.10) | 0.01 (0.02) | 0.05 (0.01) | 0.17 (0.07) | yus | −7.13 (0.94) | 0 | −0.95 (0.24) | 0.01 (0.01) | −0.01 (0.01) | 0.04 (0.02) |
| Mexico | | | | | | | Turkey | | | | | | |
| | $\beta_x$ | $\beta_m$ | $\beta_{BOP}$ | $\alpha_x$ | $\alpha_m$ | $\alpha_{BOP}$ | | $\beta_x$ | $\beta_m$ | $\beta_{BOP}$ | $\alpha_x$ | $\alpha_m$ | $\alpha_{BOP}$ |
| yme | 0 | −3.38 (0.06) | 1 | 0.07 (0.21) | −0.13 (0.29) | −0.82 (0.86) | ytr | 0 | 3.32 (0.19) | 1 | 0.42 (0.24) | −0.25 (0.13) | 0.62 (0.32) |
| xme | 1 | 0 | 0 | −1.22 (0.47) | 2.22 (0.66) | 7.03 (1.92) | xtr | 1 | 0 | 0 | 0.19 (0.52) | −0.61 (0.28) | 0.87 (0.70) |
| mme | 0 | 1 | 0 | 0.40 (0.65) | −0.30 (0.90) | −2.37 (2.63) | mtr | 0 | 1 | 0 | 1.42 (1.04) | −1.32 (0.56) | 2.67 (1.40) |
| zme | −1.70 (0.30) | −3.42 (0.47) | 0.43 (0.10) | 1.04 (0.68) | −1.38 (0.95) | −5.57 (2.78) | ztr | 9.30 (1.36) | −14.94 (2.38) | −12.41 (1.88) | 0.56 (0.44) | −0.55 (0.24) | 1.16 (0.59) |
| yus | −3.51 (0.06) | 0 | −0.95 (0.02) | 0.12 (0.09) | −0.02 (0.13) | 0.13 (0.38) | yus | −9.01 (0.35) | 0 | 5.65 (0.31) | −0.11 (0.07) | 0.05 (0.04) | −0.14 (0.10) |

**Table 6.** Tests of the BOPCG hypotheses (p-values in parantheses).

| | Brazil | Korea | Mexico | Turkey |
|---|---|---|---|---|
| $H_1$ | 14.74 (0.00) | 11.20 (0.00) | 18.05 (0.00) | No Convergence |
| $H_2$ | 3.31 (0.19) | 15.59 (0.00) | 28.84 (0.00) | 27.06 (0.00) |
| $H_3$ | 12.37 (0.00) | 9.25 (0.01) | No Convergence | 13.05 (0.00) |
| $H_2$ & $H_3$ | 42.53 (0.00) | 12.15 (0.02) | 64.28 (0.00) | 44.70 (0.00) |
| $H_4$ | 16.33 (0.00) | 4.41 (0.22) | 24.78 (0.00) | 6.91 (0.07) |
| $H_5$ | 8.12 (0.04) | 12.44 (0.00) | 25.20 (0.00) | No Convergence |

South Korea, Mexico and Turkey are also in the data set used by Perraton (2003), which covers the 1973–1995 period. While, admittedly, there is only a partial overlap of the time span, our findings on Brazil and South Korea, here, are consistent with Perraton (2003). As for Mexico and Turkey the unsatisfactory results can be attributed to the crisis prone nature of these countries and the frequent policy shifts and erratic capital flows that result in significant structural breaks in their time series, as well as poor data quality.

## IV. Final remarks

The aim of this study is to explore the issues involved in the use of a VECM framework for the estimation and testing of the BOPCG model and investigate if the use of this particular econometric framework with a relatively recent data sample provides results in support of the previous empirical results of this vast literature.

The procedure proposed by Kvedaras (2007) is a theoretically coherent and comprehensive framework for the estimation and testing of the BOPCG hypothesis; however, it requires that the variables are I (1) and the system has at least three cointegrating vectors. It involves testing non-linear restrictions on the cointegrating vectors as discussed in Pesaran and Shin (2002). Statistical software products do not offer ready-made procedures for testing

non-linear restrictions on the cointegrating vectors with the exception of OxMetrics (2018). Moreover, convergence is not always achieved and the tests are only asymptotically valid. These contingencies may have limited the empirical use of this procedure, to date.

This particular data set fulfils the requirements of the procedure in terms of time series properties and the number of cointegrating vectors. The results indicate that Thirlwall's Law is not rejected for Brazil and South Korea, while it is rejected for Mexico and Turkey over the 1980–2016 period. For South Korea, there is evidence in support of the validity of Thirlwall's Law together with the absence of the real exchange rate from the long run export and import functions. World income seems to be weakly exogenous for Korea and Turkey. There is also evidence in favour of the weak exogeneity of the real exchange rate for Brazil. There are three instances where tests cannot be conducted due to lack of convergence in the estimation of the underlying likelihood functions.

The literature around the empirical validity of the BOPCG hypothesis is vast. The results are mixed and sensitive to the choice of time horizon and econometric technique. These findings are consistent with the findings of relatively recent empirical studies by Perraton (2003), Nassif, Feijó, and Araújo (2015) and Darku (2019) that cover a similar time span.

In conclusion, our analysis using a VECM framework for the estimation and testing of the BOPCG model revealed that Thirlwall's Law is binding and empirically relevant to the analysis of economic growth in Brazil and South Korea over the 1980–2016 period. The implication is, in order to maintain economic growth in the long run, these countries can benefit from policies directed at easing the BOP constraint such as structural change in the composition of exports, attracting and productively using longer term capital inflows as well as keeping the appetite for and the dependence on imports under control.

## Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the author(s).

## References

Darku, and A. B. Darku. 2019. "Exports, Capital Inflows, Relative Prices, and Income Growth in South Korea: An Application of the Balance of Payments Constraint Growth Model." *International Journal of Finance & Economics* 24 (1): 288–295. doi:10.1002/ijfe.1662.

Darku, A. B. 2019. Exports, capital inflows, relative prices, and income growth in South Korea: An application of the balance of payments constraint growth model, *International Journal of Finance & Economics*, *24*(1), 288–295.

Johansen, S. 1995. *Likelihood Based Inference in Cointegrated Vector Autoregressive Models*. Oxford: Oxford University Press.

Kvedaras, V. 2007. "Testing the Demand Led and BOP Constrained Growth Model: A System Approach." *Applied Economics Letters* 14 (5): 367–370. doi:10.1080/13504850500426251.

McCombie, J. S. L.. 1997. "On the Empirics of Balance-Of-Payments–Constrained Growth." *Journal of Post Keynesian Economics* 19 (3): 345–375. doi:10.1080/01603477.1997.11490116.

McCombie, J. S. L. 2011. "Criticisms and Defences of the Balance of Payments Constrained Growth Model: Some Old, Some New." *PSL Quarterly Review* 64 (259): 353–392.

Nassif, A., C. Feijó, and E. Araújo. 2015. "Structural Change and Economic Development: Is Brazil Catching up or Falling Behind?" *Cambridge Journal of Economics* 39 (5): 1307–1332. doi:10.1093/cje/beu052.

OxMetrics. 2018. *Timberlake Consultants Limited*. UK: Richmond upon Thames.

Perraton, J. 2003. "Balance of Payments Constrained Growth and Developing Countries: An Examination of Thirlwall's Hypothesis." *International Review of Applied Economics* 17 (1): 1–22. doi:10.1080/713673169.

Pesaran, M. H., and Y. Shin. 2002. "Long-run Structural Modelling." *Econometric Reviews* 21 (1): 49–87. doi:10.1081/ETC-120008724.

Setterfield, M. 2011. "The Remarkable Durability of Thirlwall's Law." *PSL Quarterly Review* 64 (259): 393–427.

Thirlwall, A. P. 1979. "The Balance of Payments Constraint as an Explanation of International Growth Rate Differences." *Banca Nazionale del Lavoro Quarterly Review* 128: 45–53.

Thirlwall, A.P. 2011. Balance of payments constrained growth models: history and overview, *PSL Quarterly Review*, *64* (259), 307–351.