



An investigation of a partial Dutch disease in Botswana

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ABSTRACT

Diversification of resource-driven economies has proven to be a very stubborn problem. Even relatively successful countries struggle to achieve a structural change towards manufacturing and high-tech industries. Botswana has been often cited as one of the few countries that escaped the resource curse and performed well in terms of economic growth. However, a significant share of the domestic output and most of the exports are still coming from the mining sector. In this paper we present the spending effect as a possible explanation for the lack of economic diversity. Using a nonlinear autoregressive distributed lag model, we investigate the cointegration of the diamond price index and the pula exchange rate against the currencies of Botswana's main trading partners on monthly time-series data. Our analysis is based on a recent dataset that covers the period from the introduction of the crawling band exchange regime until 2018. The results highlight a *partial* Dutch disease phenomenon related to Botswana's trade union partners: Namibia and South Africa.

1. Introduction

Many countries with significant natural wealth suffer from what is labelled as the resource curse (Sachs and Warner, 2001). Despite the long and intense academic debate concerning the effects of resource endowment on economic and social development, results are still controversial (Papyrakis, 2016; Szalai, 2018). Botswana is often considered as one of the few success stories as it has maintained a relatively steady economic growth and political stability since the beginning of diamond mining, for almost five decades. Although the country avoided most negative effects of its booming natural resource sector, it has clearly failed to diversify from diamond extraction and achieve a structural change towards higher added value activities. Around 20% of the GDP and almost 85% of the exports are generated by the diamond industry, while the country ranks relatively low in terms of economic complexity and struggles with significant unemployment (see Table 1). Put differently, Botswana is currently being “trapped by diamonds” (Hillbom and Bolt, 2018). Since easily accessible reserves will

have been depleted in a few years, dependence causes serious concerns (Grynberg et al., 2015).

A cross-country study by Harding and Venables (2016) found that every dollar of resource revenue decreases non-resource exports by 74 cents and increases imports by 23 cents. According to the Dutch disease theory (Corden and Neary, 1982), the booming resource sector crowds-out manufacturing, drives the domestic price level upwards, and catalyses the Balassa-Samuelson effect. That is, the change in the domestic prices is followed by an equal real appreciation of the currency which causes a significant and persistent misalignment of the exchange rate.

Previous studies on the misalignment of the Botswana pula (BWP) have the common shortcoming of using the real effective exchange rate to determine if the currency is overvalued (Deléchat and Gaertner, 2008; Taye, 2012), i.e. if the Dutch disease hits the economy. As the proxy is a weighted average, these results necessarily lack the currency-specific details. In the case of Botswana, the lack of economic diversity follows from a loss of international competitiveness in manufacturing due to a

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Table 1
Selected macroeconomic indicators of Botswana.

	2001–2004	2005–2008	2009–2012	2013–2016
Average Annual Growth (%)	3.41	6.86	2.85	4.52
Unemployment (%)	21.31	17.55	17.43	18.10
Manufacturing (% of GDP)	5.79	5.56	6.12	5.53
Mining (% of GDP)	28.42	29.5	18.84	19.94
Diamond/Total Export (%)	79.82	68.88	71.52	84.77
Economic Complexity	−0.76	−0.77	−0.16	−0.76

Note: Data was collected from the following sources: Average growth is accessible via WTO Open Data. The Economic Complexity Index that “measures the knowledge intensity of an economy by considering the knowledge intensity of the products it exports” is taken from the MIT Media Lab project. (Range: 2.5 to +2.5.) Diamond exports are detailed at the IMF’s Trade Map. Unemployment, manufacturing and mining data were taken from Statistics Botswana.

partial Dutch disease. By partial we mean that the effects are limited to specific trade partners and transmission channels.

In order to test our hypothesis (H_1), we utilize non-linear autoregressive distributed lag models to separately reveal if there is a long run stochastic co-movement between diamond prices and real exchange rates of Botswana’s main trade partners. Our results suggest that diamond exports cause significant competitive disadvantage in manufacturing within the South African Customs Union (SACU) by driving the real appreciation of the BWP against the South African rand (ZAR) and the Namibian dollar (NAD).² Moreover, the specific tariff revenue sharing formula within the SACU probably further amplifies the forces limiting non-resource exports.

Additionally we test if the long run effects are asymmetric (H_2), that is, a positive price shock of unity causes the BWP to appreciate more than a negative shock of the same amplitude would cause it to depreciate. This asymmetry could further amplify the partial Dutch disease effect even when resource price movements are less volatile. However, based on our calculations, asymmetries are not present in Botswana’s trade relations.

This paper is organized into five sections. Section 2 gives an overview on both the theoretical background and the country-specific issues, while section 3 discusses the statistical properties of the selected time series. In section 4 and 5 we present our methodology and evaluate the results. Section 6 concludes.

2. Overview

The classic Dutch disease theory concerns a three-sector small open economy and suggests that a resource boom causes both direct and indirect de-industrialization (Corden and Neary, 1982; Yokoyama, 1989). As the value of the marginal product in resource extraction rises, workers start to flow from other sectors in hope of a higher real wage. This resource movement effect causes direct de-industrialization as manufacturing output falls due to lower employment. Increased wages provide more disposable income and boost the demand for domestic services along the income-consumption curve. The excess demand drives flexible prices upwards and raises the value of the marginal product in the non-tradable sector. Consequently, more workers move away from manufacturing which leads to a further decline in output. This secondary impact, called the spending effect, causes indirect de-industrialization in the long run. Put differently, the Dutch disease develops as a resource bonanza: it crowds-out manufacturing by altering the relative returns on various economic activities.

Another consequence of the spending effect is the appreciation of the

domestic currency that is likely to further impede manufacturing by causing a loss in international competitiveness. This “chronic exchange rate overvaluation” (Bresser-Pereira, 2013, p. 372) was verified by numerous studies under several different assumptions and model specifications. Beyond the original framework, Krugman (1987) adapted increasing returns to scale and showed that resource windfalls cause further specialization towards extraction, while Sachs and Warner (1995) developed an endogenous growth model where the relative price of non-tradables grows as excess revenue drives the domestic demand.

According to the Balassa-Samuelson theorem, the appreciation of the currency ensues, providing theoretical support for our analysis. In a recent paper Iacono (2018) extends the framework by incorporating the concepts of both learning-by-doing and absorption constraints, but draws the same conclusion: resource booms cause currency overvaluation. On the other hand, some models suggest that appreciation is not inevitable. Torvik (2002) finds that if learning spillovers are present in the non-tradable sector as well, then the exchange rate is likely to depreciate in the long run because of a relative increase in sector productivity. Similarly, van der Ploeg and Venables (2013) argue that appreciation only happens in the short run as adjustments take time due to the intersectoral immobility of capital. However, all theoretical models agree that if the currency appreciates, the loss in international competitiveness eventually leads to indirect de-industrialization.

The idea that the spending effect creates disadvantage in manufacturing is also supported by a growing body of empirical evidences. Mironov and Petronevich (2015) used a cointegration model to examine the structural development of the Russian economy and reported that a 1% increase in resource export revenues had caused the real effective exchange rate to appreciate by 0.2%. In accordance with the theoretical findings, they also emphasize the negative impact on manufacturing. A similar study about Australia by Koitsiwe and Adachi (2015) reveals a causal link between the increasing share of mining, the appreciation of the currency, and eventually the decrease in manufacturing output. Based on a vector autoregressive model, they conclude that 23.6% of the exchange rate fluctuation is explained by mining booms while 24.8% of the variation in manufacturing is explained by the exchange rate. In the case of Canada, Beine et al. (2012) find that currency misalignment due to the Dutch disease induced a loss of 33–39% in manufacturing employment between 2002 and 2007. However, they also note that the Canadian dollar depreciated shortly after as oil prices dropped sharply during 2009.

To contribute to the mounting body of literature, we deliberately chose a country that is highly dependent on a single resource but escapes most negative effects of resource dependence. In terms of value and volume, Botswana is the second most important diamond-producer in the world, providing around 15% of the world supply (Kimberley Process, 2017). Unlike most Sub-Saharan African economies struggling with several aspects of the resource curse, diamonds have brought about a growth miracle in Botswana. They transformed the poor, agrarian, rural, uneducated, foreign-aid dependent country (Samatar, 1999; Gwebu, 2012; Maipose, 2008) into an upper-middle income economy in the course of a generation (Hillbom, 2008). Corruption rates and societal tensions are relatively low whereas state capacity and developmental institutions are sound and strong (Robinson et al., 2003; Leith, 1999; Robinson and Parsons, 2006; Mulinge, 2008; Acemoglu and Robinson, 2010).

However, persistently high unemployment rates coupled with high production costs and competitiveness problems as well as the low level of export diversification (Jefferis, 2019, see Table 1) imply deep-seated structural transformation problems that might be related to the presence of the Dutch disease.

Tswana decision-makers used a multitude of micro- and macro-level policies from the beginning of the mining boom to counter competitiveness-related diversification problems (MITI, 2016, interview). On the macro-level, prudent exchange rate management impeded significant and permanent nominal exchange rate appreciation.

² Please note that the NAD is pegged to the ZAR at a fixed nominal rate of 1:1.

Government spending was kept below government revenue growth, surpluses were accrued, and assets were invested abroad through a sovereign wealth fund (Pegg, 2010). The government also promoted tradable sectors by establishing various subsidy schemes for arable agriculture, employment grants for agricultural industries, manufacturing and small-scale mining, and by conceiving coherent industrial policies in 1984, 1998 and 2014 respectively (MITI, 2014). Above all, the government "earmarked" the manufacturing sector „through which the twin goals of economic diversification and employment creation" (Sekwati, 2010, p. 13) would be realized.

In some respects, government policies were successful. GDP and sources of growth have become more diversified (Jefferis, 2014). The relocation of the diamond sorting and aggregation centre of the De Beers group³ from London to Gaborone in 2012 is considered as a great leap forward in local value creation (Kufa, 2016, interview). Indeed, the new processing capabilities have led to an expansion in external trade with other diamond producers (see Namibia in Table 2) and integrated Botswana one step further in the value chain.

The manufacturing sector has expanded parallel to the growing GDP but failed to grow its share within the GDP. It has not become a driver of diversification and "has consistently failed to perform to expectations" (Sekwati, 2010, p. 9). Exports are heavily dominated by diamonds (see Table 1).

Diversification-enhancing policies have only had limited success so far. This is concerning because the depletion of diamonds is forthcoming: a permanent and rapid production decline is expected to take place between 2025 and 2027, possibly putting an end to this African success story (Grynberg et al., 2015). According to a Gaborone-based think-tank, ten years after the depletion of easily accessible stocks Botswana GDP might be "47% below the non-depletion path" (Grynberg et al., 2015, p. 124).

An important reason for the failure of diversification is related to the unbalanced power relations in the region favouring the Republic of South Africa. Southern Africa's most important regional economic alliance – the South African Customs Union (SACU) – binds Botswana, Lesotho, Namibia, Swaziland and South Africa together. Referred to as the "industrial powerhouse" (Martin, 1990, p. 59), South Africa contributes more than 90% of SACU GDP and manufacturing output (McCarthy, 2014), and aggressively pursues its own interests of industrialization. This is reflected in the current revenue-sharing formula (RSF) of SACU: South Africa withholds a fixed share of customs revenue and the

remaining customs component is shared according to intra-SACU imports (Grynberg and Motswapong, 2012). As Table 2 shows, Botswana has negligible trade relations with smaller member states and imports mostly from South Africa. The more Botswana imports from other members within the union, the more it harvests from the SACU revenues. As in Botswana these incomes surmount even mineral revenues (see Jefferis, 2014, p. 9), the country is heavily dependent on this arrangement and sticks to it (Grynberg, 2016, interview) although when it comes to diversification and building a viable domestic manufacturing sector, it is clearly counter-productive.

In this paper, we intend to highlight that the failure of diversification is also related to the presence of Dutch disease in Botswana. The description of the main symptoms, such as low rates of manufacturing, overvalued currency, artificially high real wages, and unemployment (Bresser-Pereira, 2013) seem to fit, but the literature is far from consensus. Norberg and Blomstrom (1993) do not find significant evidence to corroborate Dutch disease effects in Botswana. Mogotsi (2002) analyses the 1982–1990 boom period and concludes that Botswana did experience a mild form of Dutch disease that was manifested in the form of real exchange rate appreciation which negatively affected the textile industry. Love (1994) and Molaodi (2004, 2005) both assert that the country was hit by the Dutch disease, the former based on the contraction of agriculture during the mining boom and the latter on the unbalanced non-tradeable sector growth (construction, commerce) up to 2004. Pegg (2010) contends that Botswana suffers from negative effects related to its natural resource dependence, but not through the traditional channels posited in the Dutch disease theory. According to Poteete and Marroquín (2005, p. 23), Botswana keeps Dutch disease symptoms "in check", therefore a clear diagnosis cannot be established.

Another approach is to identify possible BWP exchange rate misalignment periods. A joint Botswana Institute for Development Policy Analysis and WTO study (BIDPA and WTO, 2005) assesses the BWP real effective exchange rate from the 1970s until 2004 and only finds proof of real appreciation between 2002 and 2004. Iimi (2006, 2007) uses a behavioral equilibrium exchange rate approach and finds that BWP seems to have been undervalued in the late 1980s and overvalued by 5–10 percent from 2002 to 2005. In a more recent analysis Taye (2012) compares effective exchange rate data from 1990 to 2010 against an estimated equilibrium exchange rate over the same period and finds no evidence of long-term misalignment. Taye also concludes that the crawling peg system introduced in 2005 works adequately. Most authors agree that, notwithstanding its spectacular development, the country suffered from BWP exchange rate misalignment or Dutch disease during a certain period of its post-independence economic history, but only in a "mild form".

We have already referred to the crowding-out effect as a consequence of the Dutch disease in terms of manufacturing. In the case of Botswana, we assume that crowding-out is present (Rigler, 2019, interview) and it stems from the spending effect. We rule out the resource movement effect since (i) diamond extraction is a capital-intensive industry and (ii) the unemployment rate is traditionally high in Botswana (see Table 1). Thus, it is very unlikely that any diamond boom would divert further workers from manufacturing. On the other hand, we argue that the spending effect is significant in terms of international competitiveness as the relative increase in the price of non-tradable services would cause an equal appreciation of the domestic currency (Balassa, 1964). In order to test our theory, we examine if diamond world prices are cointegrated with the pairwise BWP exchange rates.

3. Data and time series properties

In this section we introduce our datasets and determine the time frame of our analysis. Later, we carry out the necessary transformations and run statistical tests to prepare for the modelling phase.

Table 2
Botswana's trade relations with SACU members.

	2001–2004	2005–2008	2009–2012	2013–2016
Imports from SACU (%)	81.76	83.27	71.56	74.17
Eswatini	0.04	0.01	0.07	0.08
Lesotho	0.01	0.01	0.07	0.03
Namibia	0.36	0.57	2.08	11.06
South Africa	81.35	82.68	69.34	63.00
Exports to SACU (%)	8.17	11.41	14.43	21.24
Eswatini	0.01	0.02	0.04	0.02
Lesotho	0.01	0.01	0.02	0.02
Namibia	0.09	0.47	0.82	8.30
South Africa	8.07	10.92	13.55	12.91

Note: Data was collected from WTO's WITS database. All values represent the average percentage import/export from selected SACU member country, compared to total imports/exports of the indicated time interval.

³ Debswana operates all diamond mines in Botswana and is a joint venture between the government of Botswana and the diamond company De Beers.

3.1. Data sources and time frame

We selected Botswana’s ten most considerable trade partners in the diamond market including Canada, China, India, Israel, Namibia, South Africa, Switzerland, the United Arab Emirates, the United Kingdom and the USA. Monthly financial statistics were gathered from the International Monetary Fund’s IFS database for all entries. These time series include nominal exchange rates between the BWP and the selected trade partners as well as the consumer price indices of the same countries. Using the currencies of the appropriate pairs from the time series, we have calculated the real exchange rates by the following formula⁴:

$$e_t = E_t \cdot \frac{CPI_t}{CPI_t^*} \tag{1}$$

where e_t and E_t denote real and nominal exchange rates respectively, whereas CPI_t and CPI_t^* are domestic and trade partner inflation rates at time t as measured by the consumer price index. A rise in e_t indicates the appreciation of the BWP and thus a loss of export competitiveness.

Our indicator of the monthly price change of diamonds is the Bloomberg’s Overall Diamond Index (PLPH0AAI), which weighs different diamond products by several important characteristics (e.g.: shape, carat, refraction, etc.). Although rough price indices would serve our purposes better, the available Rough Diamond Index (PLPHROAD) has a high amount of unsystematic missing observations, therefore inappropriate for statistical modelling.

In the models, p_t denotes the real price of the US dollar denominated Overall Diamond Index that is deflated with the US CPI rate which - as usual in empirical studies (Jahan-Parvar and Mohammadi, 2011) - represents the world price index. We follow the literature on exchange rate determination in Dutch disease affected countries, and after adjusting for seasonal effects, we use the logarithm of both variables to mitigate potential heteroscedasticity (Olusi and Olagunju, 2005; Yol, 2009).

Although data in general are widely available for all time series (see Table 3), we still encountered two problems. First, the Bank of Botswana, as the monetary authority of the country changed the exchange rate regime during May 2005. The former pegged regime was abandoned for a more liberal crawling band mechanism. Based on Bank of Botswana’s statistics, we believe that exchange rate fluctuations caused by the regime change diminished until the beginning of 2006.

Second, it is only possible to analyze the statistical relationship be-

Table 3
Timespan of our analysis.

	Start date	End date	Entries
CAN	Jan. 2013	May 2018	65
CHE	Jan. 2007	May 2018	137
CHN	Jan. 2006	May 2018	149
IND	Jan. 2008	Mar. 2018	125
ISR	Jan. 2006	May 2018	149
NAM	Jan. 2010	Apr. 2018	88
UAE	Jan. 2010	Dec. 2017	84
UK	Jan. 2006	May 2018	149
USA	Jan. 2006	May 2018	149
ZAF	Jan. 2006	May 2018	149
PLPH0AAI	Jan. 2006	May 2018	149

Note: Financial data are available at the International Monetary Fund’s IFS database. Overall Diamond Index can be downloaded by subscribers from the Bloomberg Terminal with the PLPH0AAI ticker.

⁴ For EU and EEC countries, only real effective exchange rates are available in the IFS statistics. For this reason we excluded Belgium, Norway, Portugal and Italy from our analysis.

tween diamond prices and exchange rates if a sufficient amount of trade took place in the specific year. For China, Israel, the Republic of South Africa, the United Kingdom and the USA, 2006 is suitable as a starting year, because all of these countries had developed a significant diamond trade with Botswana earlier. Switzerland and India started high volume diamond trade in 2007 and 2008 respectively. Namibia and the United Arab Emirates were latecomers in 2010, and finally Canada joined in 2013. The listed ten trade partners account for the majority of diamond trade with Botswana during the period of our investigation.⁵

Our data coverage spans until May 2018, but in some cases the time series are shorter due to temporarily unavailable financial reports. Namibia and India have one and two missing months respectively from the end of the series, while the United Arab Emirates had not announced the exchange rate statistics since the end of 2017. In general, the number of observations are enough to conduct single equation modeling, excluding Canada as a borderline case.

3.2. Time series properties

A long-run relationship between stochastic time series - i.e. a partial Dutch disease - can only occur if either (i) both variables are stationary or (ii) although at least one of them is non-stationary, their linear combination satisfies a required mean reverting attribute, thus they are cointegrated (Engle and Granger, 1987). In any other cases the model would be dynamically unstable, and following a shock there would be no equilibrium level to which the system could revert.

For this reason we first conducted unit root tests and verified if both time series are stationary. Table 4 reports the results of the augmented Dickey Fuller - and Phillips-Perron tests. The main difference is that the latter is more robust to heteroscedasticity and serial correlation, while it also performs better in border-line cases (Phillips and Perron, 1986). Both procedures were calculated with a drift term, and with an additional trend to account for potential world level inflation effects in the real exchange rate series. In all ADF cases the optimal lag length criterion was determined by AIC, which uniformly suggested a lag structure of one. Contrary to the findings of the ADF tests, the PP procedure identified an optimal lag structure of four, except for the case of Canada where the length was three, possibly because of the shorter sample period. All calculated test statistics are concordantly unable to reject the

Table 4
Results of stationarity tests.

	ADF tests		PP tests	
	Intercept	Int.& trend	Intercept	Int. & trend
CAN	0.35	0.14	0.42	0.08
CHE	0.17	0.42	0.11	0.30
CHN	0.27	0.36	0.43	0.40
IND	0.60	0.28	0.49	0.33
ISR	0.06	0.15	0.18	0.27
NAM	0.39	0.54	0.12	0.06
UAE	0.77	0.47	0.78	0.61
UK	0.56	0.75	0.48	0.75
USA	0.60	0.74	0.52	0.77
ZAF	0.26	0.22	0.28	0.14
PLPH0AAI	0.71	0.76	0.62	0.71

Note: The numbers indicate the corresponding p-values of the tests. The null hypothesis of the ADF and PP tests are non-stationarity. In case of the ADF tests we have applied the Akaike Information Criterion to choose the optimal lag structure which resulted in a lag order of one. Otherwise, in case of the PP tests, the lag structure is calculated automatically by the test. The PP tests suggested a fourth order lag in all cases except for Canada.

⁵ For the details please see the WITS database at the WTO.

null hypothesis of non-stationarity at a 5% significance level, therefore our results drive out the possibility of long-run relationship in levels. If a partial Dutch disease exists in specific trade relations, only cointegration tests can reveal their presence.

Currently popular cointegration testing procedures originated from Johansen (1991), but his method is based on multiple equation models. Equation system techniques consume a high amount of degree of freedom and are not suitable for our analysis. Technically the Johansen procedure with two integrated time series can only result in a maximum of one cointegrating relation. Therefore, we have only tested our time series against the null hypothesis of no cointegration (i.e. $H_0: r = 0$). Rejecting the null indicates a common linear stochastic trend for the variables in question.

Pesaran and Shin (1999) suggested a single equation autoregressive distributed lag approach to cointegration testing when the time series are moderately short. The so called bounds testing approach follows a different method. It includes the long-run variables in the model, and evaluates their joint significance by a modified F-test. The critical values of the Pesaran approach are tabulated by the authors in their seminal paper (Pesaran et al., 2001) and expanded to non-linear models by Shin et al. (2014). The test separates the possible values of the F-statistic into three intervals. A test result smaller than the lower bound critical value indicates that the underlying time series are both $I(0)$ and there is no long run common stochastic trend. On the contrary, results exceeding the upper bound indicate two $I(1)$ cointegrated processes. Between the bounds the test is inconclusive and a potential mixed cointegration has to be evaluated based on the unit root tests.

To identify possible cointegrating relationships in practice, we have calculated Johansen's trace and eigenvalue tests (Johansen, 1991) for linear cointegrating relationships. For a possible non-linear hidden cointegration the Pesaran and Shin (1999) bounds test was utilized. The significance level was 10% in both cases. Being aware of the sensitivity of the Johansen procedures in small samples, we have given a decisive role to the Pesaran bounds test in every ambiguous case.

Out of ten trade partners five, namely, Canada, Switzerland, the United Arab Emirates, the United Kingdom and the United States of America, showed no signs of cointegration based on the bounds tests (see Table 5). Among these, the United Arab Emirates and the United Kingdom might be cointegrated according to both Johansen procedures. The confusing outcome is not uncommon as Shin et al. (2014) recalls that these tests often result in contradictory outputs.

China, India, and Israel fall in the inconclusive range, but based on the fact that the ADF and the PP tests were not able to reject the null of non-stationarity, we assume that there is no cointegration among the time series in the separate models.

Table 5
Results of cointegration tests.

	Johansen Procedure		Pesaran bounds
	Trace test	Eigenvalue test	F-stat
CAN	26.08	15.70	1.69
CHE	22.57	13.05	1.29
CHN	15.01	9.05	2.56
IND	18.42	14.00	2.15
ISR	23.05	13.99	2.73
NAM	27.37	19.95	11.86
UAE	33.47	29.26	1.82
UK	24.63	17.33	0.83
USA	19.60	14.3	1.04
ZAF	20.58	15.29	3.24

Note: The columns contain the corresponding calculated test statistics for the indicated cointegration procedures. The 10% significance level critical values for the trace - and the eigenvalue tests are respectively 22.76 and 16.85. Lower and upper bounds critical values for the Pesaran bounds test are based on asymptotic theory and equal 2.12 and 3.23, excluding Canada where due to the small number of observations the values are 2.53 and 3.65.

There are two series where the bounds test denotes cointegration: Namibia and South Africa. Namibia's test outcomes give an F-test value of 11.86, far beyond the 3.23 asymptotic upper bound. The trace and eigenvalue test results are also in accordance with this finding. On the other hand, South Africa barely passes the upper bound with a 3.24 F-statistic, while the results of the Johansen procedures contradict this.

4. Methodology

According to Jahan-Parvar and Mohammadi (2011), identifying the Dutch disease through the spending effect essentially requires a stable and long-run cointegrating relationship between particular real exchange rates and the diamond price index. In section 3 we showed that diamond prices are pairwise cointegrated with the exchange rates of Botswana's two main trade partners: Namibia and South Africa.

Besides the cointegrating relations, we would also like to examine the asymmetric nature of positive and negative $\log p_t$ price shocks separately on the related $\log e_t$ real exchange rates. Therefore, following Shin et al. (2014) we deconstruct the $I(1)$ explanatory time series into partial sum processes the following way:

$$\log p_t^+ = \sum_{j=1}^t \Delta \log p_j^+ = \sum_{j=1}^t \max(\Delta \log p_j; 0) \tag{2}$$

$$\log p_t^- = \sum_{j=1}^t \Delta \log p_j^- = \sum_{j=1}^t \min(\Delta \log p_j; 0), \tag{3}$$

such that $\log p_t = \log p_t^+ + \log p_t^-$. After the transformation, we can estimate the asymmetric long-run relationship:

$$\log e_t = \beta^+ \log p_t^+ + \beta^- \log p_t^- + \xi_t, \tag{4}$$

but trends with similar slopes in the time series could lead to spurious regression and biased parameter estimates (Granger and Newbold, 1974; Hendry, 1980). To consistently estimate simultaneous short - and long-run effects, an error correction model has to be specified, where the presence of a long-run stochastic trend is separated from the short-run dynamics. Originally Engle and Granger (1987) extracted the stationary ξ_t error term from the symmetric version of equation (4):

$$\xi_t = \log e_t - \beta^+ \log p_t^+ - \beta^- \log p_t^-, \tag{5}$$

and included it in their model as an explanatory variable. By this specification, the term ξ_t represents deviations from the long-run stochastic equilibrium of the variables and it accounts for the missing effect. Alternatively Shin et al. (2014) estimate a nonlinear autoregressive distributed lag type error correction model with the same result in two steps:

$$\Delta \log e_t = \rho \log e_{t-1} + \theta^+ \log p_{t-1}^+ + \theta^- \log p_{t-1}^- + \sum_{j=1}^{n-1} \gamma_j \Delta \log e_{t-j} + \sum_{j=0}^{m-1} (\phi_j^+ \Delta \log p_{t-j}^+ + \phi_j^- \Delta \log p_{t-j}^-) + \varepsilon_t \tag{6}$$

$$\Delta \log e_t = \rho \xi_{t-1} + \sum_{j=1}^{n-1} \gamma_j \Delta \log e_{t-j} + \sum_{j=0}^{m-1} (\phi_j^+ \Delta \log p_{t-j}^+ + \phi_j^- \Delta \log p_{t-j}^-) + \varepsilon_t, \tag{7}$$

where equation (6) is estimated directly, and the original long-run parameters of equation (5) can be calculated from the model's output as follows: $\beta^+ = -\theta^+/\rho$ and $\beta^- = -\theta^-/\rho$. In equation (7), ρ represents the coefficient of the error correction term. If $\rho < 0$ and significant, then the model is dynamically stable and represents a causal relationship. Additionally, ρ measures the adjustment speed. The value of the estimated parameter indicates the percentage of correction to a shock of unity within one period. In equations (6) and (7), all coefficients of the

differenced variables - i.e. $\gamma_j, \phi_j^{+/-}$ - represent the short-run effects of the variables in question, which in terms of our analysis, are of secondary importance.

The goals of this estimation process are the following: 1) Estimate ρ , the coefficient of the error correction term to identify if the Dutch disease is present with a trade partner. 2) Determine the speed of adjustment based on the value of ρ . 3) Estimate the long run coefficients β^+ and β^- , to verify if the relation is asymmetric. Through the remainder of the paper, we estimate the error correction models between real exchange rates selected in section 3 and diamond prices following the introduced methodology.

5. Estimation results

The results from section 3 indicate that error correction models should be specified in the cases of Namibia and South Africa. Notwithstanding the fact that the obtained statistical results for South Africa contain some ambiguity, we turn to the modelling of these two countries.

After the scrutiny of the time series properties we have decided to include intercepts and trends into both of our models. Table 6 contains all results of the error correction specifications while the long run asymmetric parameter estimations are also represented.

The value of ρ indicates the presence of cointegration and measures the error correction speed. In both models the values are negative and significant on a 1% significance level, which means that our hypothesis H_1 is supported by the model. Botswana suffers from a partial Dutch disease in trade relations with Namibia and South Africa. Based on Table 2, between 2013 and 2016, approximately 74% of Botswana's imports suffered from constant competitiveness loss.

Moreover, the value of ρ for Namibia is significantly larger, indicating a much stronger attraction of the common stochastic trend. This means that 28% of the deviation from the stochastic equilibrium is corrected in each month, whenever Namibia experiences exchange rate misalignment. The same parameter value for South Africa is significantly less: 12%. The outcome clearly suggests that unsystematic

Table 6
Model estimation results.

Parameter	Namibia NARDL			South Africa NARDL		
	Coeff.	S.E.	p-value	Coeff.	S.E.	p-value
Error correction model						
Intercept	0.01	0.01	0.51	0.01	0.01	0.04**
ρ	-0.28	0.09	0.00***	-0.12	0.04	0.00***
θ^+	0.14	0.05	0.01***	0.05	0.02	0.01**
θ^-	0.01	0.09	0.87	0.07	0.04	0.1*
γ	-0.42	0.09	0.00***	0.04	0.08	0.67
ϕ^+	-0.25	0.33	0.45	-0.18	0.16	0.26
ϕ^-	-0.75	0.32	0.02**	-0.21	0.15	0.17
Trend	-0.00	0.00	0.67	0.00	0.00	0.28
Asymmetric long run parameters						
β^+	0.52	0.15	0.00***	0.43	0.14	0.00***
β^-	0.05	0.04	0.15	0.60	0.21	0.00***
Diagnostics						
	p-value		p-value			
R^2	0.41		0.12			
$Adj.R^2$	0.37		0.08			
χ^2_{sc}	0.74		0.65			
χ^2_H	0.60		0.00			
W_{LR}	0.21		0.62			

Note: The error correction panel shows the model estimations of equation (6), while the asymmetric long run parameters were acquired from equation (4). Both equations were estimated with the R implementation of Zaghoudi (2018). Among model diagnostics χ^2_{sc} denotes the LM test for serial correlation, and χ^2_H the test for residual heteroscedasticity. W_{LR} denotes the long run symmetry test of the long run parameters. Stars indicate parameter significance in the usual manner: *p < 0.10, **p < 0.05, ***p < 0.01.

diamond price shocks cause long-lasting misalignment of the ZAR, eventuating competitiveness loss in all non-resource sectors of Botswana.

The β asymmetric long run parameters are calculated using the estimated values of the error correction term and the θ values from the error correction model. Namibia's long run parameters seemingly show a huge difference. A value of 0.52 means that for a 1% appreciation in the exchange rate of BWP, the price index of diamonds has to increase by 1.94%. Although it is a credible rate of response to a price shock, it is suggestive that the β^- value is not statistically different from zero even at a 10% significance level. This would mean that there is no chance of exchange rate correction in the long run, which seems an extreme assumption since it would lead to irreversible repercussions in trade relations. Fortunately, turning to model diagnostics, we can observe that the long run symmetry test - with the null hypotheses of long run parameter symmetry - cannot be rejected in our models on any conventional significance level. The p-values are 0.21 and 0.62, respectively. By these results we reject our second hypothesis H_2 , which states that potential long run asymmetries intensify the already deteriorating expectations.

We also run further diagnostic tests to verify our models. The model fit of the Namibia specification is approximately average, while the South Africa model has only a very limited adjusted R^2 of 7.9%. Furthermore, based on the LM test there is no sign of serial correlation in either of the models, but the estimation for South Africa suffers from ARCH effects.

We consider our results as evidence for the cointegration and the consequent Dutch disease phenomena in the aforementioned trade relations, but this effect is symmetric in its long run parameters. The model for Namibia can be considered as a well-defined approximation of the original data generating process, while the model for South Africa is less practicable.

6. Conclusion

Botswana, an African success story of resource-based development, is surprisingly unsuccessful in diversifying its economy away from diamonds. In this paper, we suggest that diamond price fluctuations from 2006 to 2018 caused real exchange rate appreciation in certain trade relations. Subsequent tradables sector competitiveness problems vis-a-vis particular trade partners probably played an important role in the failure of recent diversification efforts.

Using separate nonlinear autoregressive distributed lag models, we tested whether there is a long run stochastic co-movement between diamond prices and the real exchange rates of Botswana's main trade partners. We also tested whether long-run effects are asymmetric. We have found no evidence of asymmetry but out of Botswana's ten most important diamond trading partners, we revealed significant real exchange rate effects in the cases of Namibia and South Africa. Since these two countries account for 74% of the overall value of Botswana's imports, and all three countries are members of the SACU, the consequences are far-reaching. Taken the massive reserves in labor force (See Table 1), de-industrialization due to the resource movement effect is likely to be insignificant. Thus, Botswana suffers from a partial Dutch disease - limited in scope to the spending effect and specific to particular trade relations. The 2012 relocation of De Beers' diamond sorting and aggregation centre to Botswana's capital was a milestone in raising local added value but it also reshuffled diamond commerce and resulted in unintended exchange rate pressure with regards to key trading partners. Our empirical results draw decision-makers' attention to these pressures that must be contemplated when formulating the country's development strategy.

We are convinced that the identified partial Dutch disease is an important factor in the failure of diversification policies. As diamond price booms increase disposable income and boost the demand for domestic services, the change in the price ratio translates to an equal

change in the real exchange rate and causes the BWP to appreciate against the NAD and the ZAR. The domestic manufacturing sector is losing international competitiveness and fails to achieve economies of scale. Appreciation-related competitiveness problems are exacerbated by the peculiar revenue-sharing formula of the SACU, rewarding imports from South Africa. These influences make the development of domestic manufacturing in Botswana more difficult.

Our methodology, the country-level separation of the exchange rate effects differs from previous efforts to reveal the presence of the Dutch disease in Botswana. Former evidence was less robust as most authors investigated the spending effect on a global level as measured by the real effective exchange rate. We, on the other hand, focused on specific trade relations of importance and concluded that the Dutch disease evolves on a regional level. Beyond the specific case of Botswana, our results suggest that analyzing pairwise foreign exchange effects helps to resolve some controversies in the resource curse literature. Some resource exporter countries have a partial experience of the Dutch disease because the negative impact is limited to specific transmission channels and/or trade relations. We presume that extending research on these partial effects would improve the robustness of the empirical evidence, provide a better understanding of the problem, and yield more efficient policy proposals.

As pointed out at the beginning of this paper, Botswana is considered one of the developmental success stories of the continent. However, due to the depletion of easily accessible diamond reserves in the near future, the sustainability of the country's forty-year development comes into question. Our intention was to contribute to a deeper understanding of the evolution of Botswana economy and arm decision-makers with thorough empirical results when weighing the future directions of economic diversification policies.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRedit authorship contribution statement

Tamás Barczikay: Methodology, Formal analysis, Writing - review & editing. **Zsuzsanna Biedermann:** Project administration, Investigation, Writing - original draft. **László Szalai:** Conceptualization, Investigation, Writing - original draft.

References

- Acemoglu, D., Robinson, J., 2010. The Role of Institutions in Growth and Development. *Review of Economics and Institutions*, vol. 1. <http://www.rei.unipg.it/rei/article/view/14>.
- Balassa, B., 1964. The purchasing-power parity doctrine: a reappraisal. *J. Polit. Econ.* 72, 584–596. <https://doi.org/10.1086/258965>. URL <http://www.journals.uchicago.edu/doi/10.1086/258965>.
- Beine, M., Coulombe, S., Vermeulen, W.N., 2012. Dutch disease and the mitigation effect of migration: evidence from Canadian provinces. In: CESifo Working Paper Series 3813. CESifo Group Munich. URL <https://ideas.repec.org/p/ces/ceswps/3813.html>.
- BIDPA, W.T.O., 2005. Exchange rates and export competitiveness. In: Technical Report. BIDPA – World Bank. Prepared for the World Bank Study on Export Diversification in Botswana – Discussion Draft. Direct Access to the Paper.
- Bresser-Pereira, L.C., 2013. The value of the exchange rate and the Dutch disease. *Revista de Economia Política* 33, 371–387. <https://doi.org/10.1590/s0101-31572013000300001>.
- Corden, M.W., Neary, P.J., 1982. Booming sector and de-industrialisation in a small open economy. *Econ. J.* 92, 825–848.
- Deléchat, C., Gaertner, M., 2008. Exchange rate assessment in a resource - dependent economy: the case of Botswana. Technical report. International Monetary Fund.
- Engle, R., Granger, C., 1987. Co-integration and error correction: representation, estimation, and testing. *Econometrica* 55, 251–276. URL <http://www.jstor.org/stable/1913236>.
- Granger, C., Newbold, P., 1974. Spurious regressions in econometrics. *J. Econom.* 2, 111–120. URL <https://EconPapers.repec.org/RePEc:eee:econom:v:2:y:1974:i:2:p:111-120>.

- Grynberg, R., 2016. Interview with Roman Grynberg. University of Namibia, Windhoek, 12 January 2016.
- Grynberg, R., Motswapong, M., 2012. SACU revenue sharing formula: towards a developmental agreement. In: Technical Report July. Botswana Institute for Development Policy Analysis.
- Grynberg, R., Sengwaketse, M., Motswapong, M., 2015. Botswana after diamonds: a study into the consequences and responses to the depletion of Botswana's diamonds. In: Botswana Institute for Development Policy Analysis Direct Link to the Paper.
- Gwebu, T., 2012. Botswana's mining path to urbanisation and poverty alleviation. *J. Contemp. Afr. Stud.* 30, 611–630. <https://doi.org/10.1080/02589001.2012.724868>. URL 10.1080/02589001.2012.724868.
- Harding, T., Venables, A.J., 2016. The implications of natural resource exports for nonresource trade. *IMF Econ. Rev.* 64, 268–302. <https://doi.org/10.1057/imfer.2015.43>.
- Hendry, D., 1980. Econometrics-alchemy or science? *Economica* 47, 387–406. <https://doi.org/10.2307/2553385>.
- Hillbom, E., 2008. Diamonds or development? a structural assessment of Botswana's forty years of success. *J. Mod. Afr. Stud.* 46, 191–214. <https://doi.org/10.1017/S0022278X08003194>.
- Hillbom, E., Bolt, J., 2018. Botswana—a Modern Economic History: an African Diamond in the Rough. Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-73144-5>.
- Iacono, R., 2018. The Dutch disease revisited: absorption constraint and learning by doing. *Portuguese Econ. J.* 17, 61–85. <https://doi.org/10.1007/s10258-017-0137-x>. URL https://ideas.repec.org/a/spr/portec/v17y2018i1d10.1007_s10258-017-0137-x.html.
- Imi, A., 2006. Did Botswana escape from the resource curse? International monetary fund. In: IMF Working Paper 06/138. URL <https://www.imf.org/external/pubs/ft/wp/2006/wp06138.pdf>.
- Imi, A., 2007. Escaping from the resource curse: evidence from Botswana and the rest of the world. In: IMF Staff Papers, vol. 54. International Monetary Fund. URL https://www.jstor.org/stable/30035929?seq=1#page_scan_tab_contents. No. 4.
- Jahan-Parvar, M., Mohammadi, H., 2011. Oil prices and real exchange rates in oil-exporting countries: a bounds testing approach. *J. Develop. Area.* 45, 313–322. URL <https://ideas.repec.org/a/jda/journal/vol.45year2011issue1pp313-322.html>.
- Jefferis, K., 2014. The Botswana development model since 1966: evaluation of diversification efforts. what worked? what didn't?. In: Paper Presented at BIDPA-UB-FES Conference on "Are Diamonds There Forever? – Prospects of a Sustainable Development Model for Botswana".
- Jefferis, K., 2019. EConsult Managing Director, Former Deputy Director of the Bank of Botswana, Data and Information Exchange via E-Mail. May 2019.
- Johansen, S., 1991. Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica* 59, 1551–1580. URL <http://www.jstor.org/stable/2938278>.
- Kimberley Process, 2017. Kimberley process certification scheme. URL https://kimberleyprocessstatistics.org/static/pdfs/public_statistics/2017/2017Charts.pdf. (Accessed 10 June 2019).
- Koitsiwe, K., Adachi, T., 2015. Australia mining boom and Dutch disease: analysis using var method. In: ISES 3rd and 4th Economics and Finance Confer-Ence, vol. 30. *Procedia Economics and Finance*, pp. 401–408. [https://doi.org/10.1016/S2212-5671\(15\)01307-6](https://doi.org/10.1016/S2212-5671(15)01307-6). URL <http://www.sciencedirect.com/science/article/pii/S2212567115013076>.
- Krugman, P., 1987. The narrow moving band, the Dutch disease, and the competitive consequences of mrs. thatcher: notes on trade in the presence of dynamic scale economies. *J. Dev. Econ.* 27, 41–55. [https://doi.org/10.1016/0304-3878\(87\)90005-8](https://doi.org/10.1016/0304-3878(87)90005-8). URL <http://www.sciencedirect.com/science/article/pii/0304387887900058>.
- Kufa, L., 2016. Economic Consultant. Institute for Public Policy Research, Windhoek, 11 January 2016.
- Leith, C., 1999. Why Botswana Prospered. McGill-Queen's University Press, Montreal and Kingston.
- Love, R., 1994. Drought, Dutch disease and controlled transition in Botswana agriculture. *J. South Afr. Stud.* 20, 71–83. <https://doi.org/10.1080/03057079408708387>. URL 10.1080/03057079408708387.
- Maiposo, G., 2008. Policy and institutional dynamics of sustained development in Botswana. In: World Bank 35. Commission on Growth and Development Working Paper.
- Martin, W.G., 1990. The making of an industrial South Africa : trade and tariffs in the interwar period. *Int. J. Afr. Hist. Stud.* 23, 59–85. URL <https://www.jstor.org/stable/219981>.
- McCarthy, C., 2014. Industrial policy in Southern African regional integration and development. In: Technical Report May. Trade Law Centre.
- Mironov, V.V., Petronevich, A., 2015. Discovering the signs of Dutch disease in Russia. *Resour. Pol.* 46, 97–112. URL <https://EconPapers.repec.org/RePEc:eee:jrpoli:v:46:y:2015:i:p2:p:97-112>.
- MITI, 2014. Industrial development policy for Botswana. In: Technical Report. Government of Botswana, Botswana, Gaborone. Government Paper No. 3.
- MITI, 2016. Interview with Civil Servants and Experts at the Ministry of Investment. Trade and Industry, Gaborone, 5 January 2016.
- Mogotsi, I., 2002. Botswana's diamond boon: was there a Dutch disease? *S. Afr. J. Econ.* 70, 128–155. <https://doi.org/10.1111/j.1813-6982.2002.tb00041.x>. URL <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1813-6982.2002.tb00041.x>.
- Molaodi, P., 2004. Strong pula inhibits FDI flow. *Mmegi Online* 21. URL <https://www.mmegi.com/2004/August/Tuesday31/4895349061431.html>.
- Molaodi, P., 2005. Government caught by 'Dutch disease'. *Mmegi Online* 22.
- Mulinge, M., 2008. Botswana, Africa's haven of ethnic peace and harmony: what future prospects. *Afr. J. Sociol.* 6, 60–84.

- Norberg, H., Blomstrom, M., 1993. Dutch Disease and Management of Windfall Gains in Botswana. Routledge, London, pp. 152–167 (chapter 9).
- Olusi, J., Olagunju, M., 2005. The primary sectors of the economy and the Dutch disease in Nigeria. *Pakistan Dev. Rev.* 44, 159–175. URL: <https://EconPapers.repec.org/RePEc:pid:journl:v:44:y:2005:i:2:p:159-175>.
- Papyrakis, E., 2016. The resource curse - what have we learned from two decades of intensive research: introduction to the special issue. *J. Dev. Stud.* 1–11. <https://doi.org/10.1080/00220388.2016.1160070>. URL: <http://www.tandfonline.com/doi/full/10.1080/00220388.2016.1160070>.
- Pegg, S., 2010. Is there a Dutch disease in Botswana? *Resour. Pol.* 35, 14–19. <https://doi.org/10.1016/j.resourpol.2009.07.003>.
- Pesaran, Shin, Y., 1999. An Autoregressive Distributed-Lag Modelling Approach to Cointegration Analysis. Cambridge University Press, pp. 371–413. <https://doi.org/10.1017/CCOL521633230.011> (chapter 11). *Econometric Society Monographs*.
- Pesaran, Shin, Y., Smith, R., 2001. Bounds testing approaches to the analysis of level relationships. *J. Appl. Econom.* 16, 289–326. URL: <https://ideas.repec.org/a/jae/japmet/v16y2001i3p289-326.html>.
- Phillips, P.C., Perron, P., 1986. Testing for a unit root in time series regression. In: Cowles Foundation Discussion Papers 795R. Cowles Foundation for Research in Economics. Yale University. URL: <https://ideas.repec.org/p/cwl/cwldpp/795r.html>.
- van der Ploeg, F., Venables, A.J., 2013. Absorbing a windfall of foreign exchange: Dutch disease dynamics. *J. Dev. Econ.* 103, 229–243. <https://doi.org/10.1016/j.jdeveco.2013.03>. URL: <https://ideas.repec.org/a/eee/deveco/v103y2013icp229-243.html>.
- Poteete, A., Marroquín, A., 2005. Overlapping sectors: Botswana's inoculation against the Dutch disease? Technical report. In: Working Paper. George Mason University, Washington, DC.
- Rigler, V., 2019. Team Leader, Rural Development and Economic Cooperation, EU Delegation to Pakistan, Former Economic Attaché of the Delegation of the European Union to Botswana and SADC, Interview in E-Mail. April 2019.
- Robinson, J., Acemoglu, D., Johnson, S., 2003. *An African Success Story: Botswana*. Princeton University Press, Princeton, pp. 80–119 (chapter 4).
- Robinson, J., Parsons, N., 2006. State formation and governance in Botswana. *J. Afr. Econ.* 15, 100–140.
- Sachs, J.D., Warner, A., 1995. Natural resource abundance and economic growth. In: NBER Working Papers 5398. National Bureau of Economic Research, Inc.. URL: <https://EconPapers.repec.org/RePEc:nbr:nberwo:5398>
- Sachs, J.D., Warner, A., 2001. The curse of natural resources. *Eur. Econ. Rev.* 45, 827–838. [https://doi.org/10.1016/S0014-2921\(01\)00125-8](https://doi.org/10.1016/S0014-2921(01)00125-8).
- Samatar, A., 1999. *An African Miracle: State and Class Leadership, and Colonial Legacy in Botswana Development*. Heinemann, Portsmouth.
- Sekwati, L., 2010. Economic diversification: the case of Botswana. In: Technical Report. Revenue Watch Institute.
- Shin, Y., Yu, B., Greenwood-Nimmo, M., 2014. Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework (chapter 9). Springer New York, New York, NY, pp. 281–314. https://doi.org/10.1007/978-1-4899-8008-3_9. URL: 10.1007/978-1-4899-8008-3_9.
- Szalai, L., 2018. A review on the resource curse. *Periodica Polytech. Soc. Manag. Sci.* 26, 179–189. <https://doi.org/10.3311/PPso.10021>. URL: <https://pp.bme.hu/so/article/view/10021>.
- Taye, H., 2012. Is the Botswana pula misaligned?. In: Working Paper 33. Botswana Institute for Development Policy Analysis BIDPA.
- Torvik, R., 2002. Natural resources, rent seeking and welfare. *J. Dev. Econ.* 67, 455–470. [https://doi.org/10.1016/S0304-3878\(01\)00195-X](https://doi.org/10.1016/S0304-3878(01)00195-X). URL: <http://linkinghub.elsevier.com/retrieve/pii/S030438780100195X>.
- Yokoyama, H., 1989. Export-led industrialization and the Dutch disease. *Develop. Econ.* 27, 427–445. <https://doi.org/10.1111/j.1746-1049.1989.tb00171.x>.
- Yol, M., 2009. Exchange rate behaviour in an oil-dependent economy: the experience of the sudanese dinar. *Indian Econ. Rev.* 44, 69–88. URL: <http://www.jstor.org/stable/29793928>.
- Zaghdoudi, T., 2018. nardl: an r package to estimate the nonlinear cointegrating autoregressive distributed lag model. R documentation. URL: <https://cran.r-project.org/web/packages/nardl/index.html>.