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Original Article

After Papua New Guinea's Resource Boom: Is the Kina Overvalued?

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Abstract

Papua New Guinea's (PNG) resource boom has come to an end. Theory suggests that the real exchange rate (RER) should subsequently depreciate in order to restore internal and external balance. In practice, however, the imposition of foreign exchange controls has led to a large backlog in foreign currency orders suggesting that the RER is significantly overvalued. The purpose of this paper is to inform the ongoing policy debate surrounding this issue by estimating the extent to which PNG's RER is currently misaligned. Our results suggest that the kina should depreciate by about 20% to close the gap between the actual and equilibrium value of the RER. Otherwise PNG is likely to pay high economic costs as real overvaluation sustained through foreign exchange restrictions led to resource misallocation, lower economic growth, black markets, and ultimately a balance of payments crisis in many other developing countries in the past.

Key words: Natural resource boom, Macroeconomic adjustment, Real exchange rate misalignment, Exchange rate policy, Papua New Guinea

1. Introduction

Papua New Guinea (PNG) is by far the most populous and largest economy of developing Oceania. PNG is richly endowed in natural resources but so far has failed to convert this wealth into economic development.¹ The phrase "resource curse" is often used to describe this puzzling observation.

An important channel through which natural resource wealth negatively affects economic development is that the volatility in commodity prices introduces costly macroeconomic instabilities via the real exchange rate (RER) (Frankel, 2010). The mechanism is as follows. During a commodity price boom, the RER appreciates which hampers the profitability of the tradable sector. As a consequence, the size of the tradable sector declines as resources move into the more competitive nontradable sector (Corden & Neary, 1982). This phenomenon is known as the "Dutch Disease".² After the boom ends, export earnings dry up, current account deficits widen, and often reach unsustainable levels. Thus, the appropriate macroeconomic adjustment process to restore internal and external balance after the end of a natural resource boom is a significant depreciation in the RER.

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1. With a GDP per capita income of US\$ 2268 in 2015, the World Bank classes PNG as a lower middle-income country. The human development index (HDI) value in 2014 remains low at 0.505 (rank 155 out of 188 countries).

2. The news magazine *The Economist* coined this term in the 1970s to describe the adverse economic effects following the discovery of a natural gas field in the Netherlands.

While it is subject to debate whether the Dutch Disease harms economic growth in developing countries³, there is a consensus that interference in the macroeconomic adjustment process by resisting sufficient real depreciation imposes high economic costs. However, the latter often happens in developing countries since maintaining an overvalued exchange rate helps curb inflation and preserve purchasing power in terms of imports. To keep trade deficits under control the authorities then frequently resort to quantitative restrictions on imports and foreign exchange controls. While these measures prevent an immediate balance of payments crisis, they come at the high cost of reducing welfare and economic efficiency due to misallocation of resources (Edwards, 1989). Indeed there is overwhelming empirical evidence that RER overvaluation significantly harms economic growth in developing countries (Cottani et al., 1990; Ghura & Grennes, 1993; Rodrik, 2008; Schröder, 2013).⁴

PNG is an illuminating showcase of a developing country that underwent a commodity boom and resists macroeconomic adjustment afterwards. Since 2012, commodity prices have fallen substantially, which resulted in mounting pressure on PNG's external position. Foreign exchange reserves have fallen from US\$ 4 billion in 2012, to around US\$1.7 billion in 2016. However, this release of reserves has not sated demand at the current exchange level. As a result, the Bank of Papua New Guinea (BPNG) began to ration foreign exchange. Reportedly, the excess demand for

foreign currency is about US\$ 1 billion and rising.⁵

An important reason for why the central bank has not allowed sufficient real depreciation is that in addition to fears of inflation and keeping imports affordable, the equilibrating RER (ERER) is unobserved. It is therefore difficult for policy makers to know by how much, even approximately, the RER is currently misaligned. While estimates such as a 40% kina overvaluation circulate in the popular press^{6, 7}, it is not clear what these are based on. The IMF (2015) on the other hand employs various well-established estimation methods and finds that PNG's RER is on average undervalued, which seems highly implausible in light of recent events, and also contradicts its own conclusion in the same report that the exchange rate should be allowed to depreciate. Perhaps not surprisingly, Loi Bakani, Governor of BPNG, has repeatedly expressed his reluctance to significantly devalue the kina due to the uncertainty surrounding the value of the ERER.⁸

The purpose of this paper is to inform the ongoing policy debate about the extent to which the kina is currently overvalued. To this end we follow a theory-informed approach to formally estimate misalignment in PNG's RER. In particular, we use the single-equation approach (Edwards, 1989; Elbadawi, 1994; Baffes et al., 1999), which we deem the most reliable among the various alternatives. The method estimates the ERER as a function of a set of macroeconomic fundamentals. To do so

3. It is often argued that the Dutch Disease contributes to the resource curse in that it hampers long-run economic growth by reducing the size of the manufacturing sector in which positive externalities are more pronounced than in other sectors of economic activity. However, there is little empirical evidence of greater externalities in the tradable than nontradable sector (Eichengreen, 2008). In addition, Schröder (2017a) finds that an equilibrium appreciation in the RER (e.g. due to a resource boom) does not adversely affect macroeconomic performance in developing countries.

4. One of the channels of this is that misallocation of resources at the micro level substantially reduces aggregate total factor productivity (TFP) as shown by Restuccia and Rogerson (2008), Hsieh and Klenow (2009), and others.

5. Business Advantage PNG (6 October, 2015), "Foreign exchange controls affect Papua New Guinea business as ANZ calls for changes to kina trading range", http://www.shanghaidaily.com/article/article_xinhua.aspx?id=330368, October 5.

6. Jemima Garrett (24 June, 2016), "The argument for devaluing Papua New Guinea's currency", *ABC News*, <http://www.abc.net.au/news/2016-06-23/the-argument-for-devaluing-papua-new-guinea/s7538262>, October 5.

7. Matt Burgess (30 June, 2016), "News Analysis: PNG needs structural changes before sovereign bond issuance", *Shanghai Daily*, http://www.shanghaidaily.com/article/article_xinhua.aspx?id=330368, October 5.

8. David James (18 May, 2016), "Papua New Guinea's central bank 'determined' to get foreign currency in, says Bakani", *Business Advantage PNG*, <http://www.businessadvantagepng.com/central-bank-determined-get-foreign-currency-loi-bakani>, October 5.

we employ the fully-modified ordinary least squares (FMOLS) estimator due to Phillips and Hansen (1990). The sample period is over 1980-2016.⁹ We then compute the degree of RER misalignment on the basis of our ERES estimate.

Our results suggest that PNG's RER was overvalued by about 24% in 2015. Between 2015 and early 2016, the kina steadily lost its value vis-à-vis US dollar at a rate of about 1% per month, which reduced the estimated extent of real overvaluation to about 17% in 2016. For 2017, we anticipate an increase in the degree of RER overvaluation back to 20-22%, unless there are significant changes in BPNG's exchange rate policy and/or movements in the ERES fundamentals. This is so because the nominal exchange rate has remained stable ever since March 2016, while at the same time there is an expected inflation differential between PNG and its main trading partners (7.5% versus 1.5%). The policy implication is that the BPNG should devalue the kina by about 20% in order to avoid the extraordinary high costs associated with RER overvaluation.

The rest of the paper is organized as follows. Section 2 provides contextual information, Section 3 describes the concept of the ERES, Section 4 explains the data sources and our estimation method, Section 5 discusses the results, and Section 6 concludes.

2. PNG Context

PNG is rich in natural resources such as crude oil, copper, silver, nickel, cobalt, and gold. Since the launch of the PNG LNG project in 2014, a development with an initial investment of US\$ 19 billion (40% of 2015 GDP), PNG also produces and processes liquefied natural gas (LNG). Despite this vast wealth in primary commodities, PNG's citizens today are hardly better off than they were at independence from Australia in 1975.¹⁰

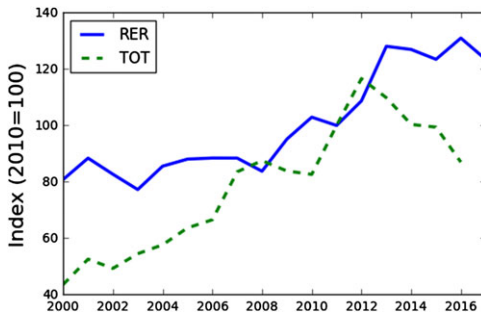
9. In the initial version of our paper, the sample period was 1980-2015.

10. According to the Penn World Tables (PNG), real GDP per capita (PPP) was \$2430 in 1975 and \$2784 in 2010. The latest version of the PWT (9.0) does not include PNG.

Dutch Disease impacts of periodic commodity price booms and difficulties to economically adjust afterwards are recurrent issues in PNG. There have been three major natural resource booms since the 1970s. The first took place between 1971 and 1977. PNG's economy expanded rapidly during this boom and adjusted well when it ended in that the nominal exchange rate depreciated by about 10% in 1975/76 and fiscal deficits were brought under control (Avalos et al., 2015). The second boom on the other hand ended in a large-scale financial crisis in 1994. In contrast to the 1970s, fiscal management went awry. Revenue declined due to a reduction in natural resource prices and foreign grants while the Bougainville conflict and the rising high cost of public service meant higher government expenditure (Dinnen, 1995). As a result, fiscal deficits reached more than 10% of GDP and public debt rose to 120% of GDP in 1994. In light of soaring inflation and declining foreign exchange reserves, the kina was devalued by 12% vis-à-vis the US dollar in September 1994, and finally floated shortly thereafter. The government introduced several expenditure controls including a wage and hiring freeze to bring the fiscal situation under control. Nonetheless, PNG's macroeconomic performance was disastrous for the rest of the decade with negative GDP growth rates of 3.5% or less in every subsequent year until 1999.

PNG only fully recovered in the early 2000s when global commodity prices shot up, which marked the beginning of the third resource boom. There was thus a sharp improvement in the terms of trade (TOT) and a concomitant RER appreciation of more than 50% (see Figure 1). From 2004 onwards, the economy expanded robustly, as annual real growth rates were rarely below 5%. Moreover, public debt declined from the former highs of 62% of GDP to about 22% of GDP in 2011. The PNG LNG project was expected to provide a further impetus to the country's resource boom. However, commodity prices have seen a price shock, with the oil price falling by as much as 70%, and current prices being 50% less than they were in 2014.

Figure 1 RER and TOT, 1999-2016. Note: An increase in RER denotes appreciation.



The drop in commodity prices has led to a precarious fiscal situation. Even though revenue has declined substantially, the PNG government continued to increase spending. The resulting budget deficits were among the largest in history, with 9.5% and 8.5% of GDP in 2013 and 2014, respectively. In 2015/16, the government reacted by introducing harsh austerity measures that exceeded even those of Greece during the euro crisis (measured as budget cuts in terms of GDP)¹¹, but deficits remained high at around 4% of GDP. Consequently, public debt shot back up to about 36% of GDP in 2016. Should these high budget deficits persist, fiscal sustainability will be jeopardized as was repeatedly the case in the 1990s.

Other macroeconomic indicators have also been worsening. During the boom years, inflation was low at around 3.5%, but since then has been steadily increasing. The latest forecasts for 2017 suggest an inflation rate of around 7.5%. Moreover, real non-resource GDP per capita, the most relevant measure of the average citizen's living standard, has fallen from 2,479 kina to 2,282 kina between 2013 and 2016.¹² Nationwide employment is also at its lowest level since 2012. Finally, there is a poor

11. Paul Flanagan (January 5, 2016), *Financial Review*, <http://www.afr.com/news/world/oceania/pngs-economy-is-a-greek-tragedy-in-the-making-20160104-glz93w>, October 11.

12. Paul Flanagan (November 2, 2016), "PNG economy - Forecasting confusion undermines confidence but recession confirmed", <http://pngconomics.org/?p=355>, November 8, 2016.

13. Imports have plummeted from formerly 50% of GDP to only about 15% of GDP in 2016.

business climate in PNG, especially due to the foreign exchange rationing which led to a sharp fall in imports in 2015/16 reflecting the increased difficulty of PNG businesses to source crucial capital goods and intermediate inputs from the rest of the world.¹³ Indeed, in a 2017 PNG Business Advantage survey, 59.5% of CEOs named access to foreign exchange as "the major obstacle" to their business operations.

3. Estimating Real Exchange Rate Misalignment

It is well-known that both absolute and relative purchasing power parity (PPP) fail to hold over periods of interest to policymakers.¹⁴ This implies that the ERER varies over time and needs to be estimated. Our point of departure is to define both the actual and equilibrium RER.

The real exchange rate (RER) is defined as the relative price of nontradable to tradable goods, expressed in domestic currency. That is,

$$RER = \frac{P_{NT}}{E \times P_{TR}} \quad (1)$$

where P_{NT} and P_{TR} reflects the price index for nontradables and tradables, respectively. E is the nominal exchange rate measured as domestic currency per unit of foreign currency. An increase in the index denotes a real appreciation.

In his seminal contribution, Nurkse (1945) defines the equilibrium RER (ERER) as the value of the RER, which attains both internal and external balances, taking as given sustainable values of all the relevant variables. Internal balance prevails when nontradable goods and labor markets clear. External balance refers to a situation where the country's external position is on a "sustainable" path.¹⁵

There are various methods to estimate the degree of RER misalignment: Purchasing power parity adjusted for the Balassa-Samuelson

14. Reasons for this are, among others, trade barriers, transaction costs, imperfect competition, and short-term disturbances in nominal exchange rates.

15. Alternatively, external balance is satisfied when the current account deficit can be financed through sustainable capital inflows.

effect (PPP-BS) as in Rodrik (2008), the macroeconomic balance (MB) methodology, or the single-equation approach (SEA). While every method has its relative merits we argue that the SEA is the preferable one.

The PPP-BS method regresses the RER on real GDP per capita, typically over five-year periods. The residual of that regression represents the estimated deviation, or RER misalignment, from Balassa-Samuelson adjusted PPP. While PPP-BS is straightforward an easy to implement, the issue with this approach is that the method is not consistent with the Nurksian definition of the ERER. This is so because an economy can be in external balance even if the RER deviates from the PPP-BS equilibrium (Cline & Williamson, 2007).

The MB framework employs a two-step procedure to compute the ERER. Step one designates a current account "norm", either in an *ad hoc* fashion or by estimating the current account norm as a function of macroeconomic variables. Step two calculates on the basis of trade elasticities the change in the RER needed (RER misalignment) to close the gap between the actual and norm current account. The focus of the MB framework thus lies solely on external balance by assuming that the economy is always in internal equilibrium. However, the most fundamental problem of this approach is that the results are highly sensitive to even small changes in the current account norm or trade elasticities. In any case, there are no estimates on either the current account norm or the trade elasticities in the context of PNG to begin with.

The strength of the SEA is how well the method incorporates the corner pillars of internal and external equilibriums. Furthermore, in contrast to MB, no intermediate steps are required, which makes the SEA misalignment estimates remarkably robust across the use of different data sources, estimation methods,

and sample periods (Schröder, 2017b). An issue with the SEA arises when choosing between panel or individual-country data. Researchers often prefer the former to overcome potential small sample problems.¹⁶ However, implicit in doing so is the assumption of homogenous long-run RER behavior across countries, which is not compatible with the theory of the ERER and may thus generate misleading results (Schröder, 2013). In light of this discussion, we estimate RER misalignment following the SEA using PNG-specific data.

The ERER definition of Nurkse (1945) implies that the ERER is determined by a set of macroeconomic variables. Edwards (1989), Montiel (1999), and Faruqee (1995) formally derive the ERER as a function of the following macroeconomic fundamentals:

$$ERER = ERER \left(\underbrace{TOT}_{(+/-)}, \underbrace{\psi}_{(+)}, \underbrace{\phi}_{(-)}, \underbrace{G_N}_{(-)}, \underbrace{G_T}_{(+)}, \underbrace{NFA}_{(+/-)} \right) \quad (2)$$

where *TOT* denotes the net barter terms of trade (defined as the ratio of export price to import price), ψ the country's stance on trade openness, and ϕ productivity differentials between PNG and its trading partner countries (Balassa-Samuelson effect). *GN* and *GT* refer to government consumption on nontradable and tradable goods, respectively. *NFA* represents the net foreign asset position. The signs of the partial derivatives are placed below.¹⁷

The above specification follows Faruqee (1995) who models external balance using a "stock-flow" approach in that the ERER is a function of the net external position which itself feeds back on the non-exogenous component of net capital flows.

An alternative specification, a pure "flow" approach, is applicable for countries which face a binding credit constraint and hence a floor on the level of net international indebtedness:

$$ERER = ERER \left(\underbrace{TOT}_{(+/-)}, \underbrace{\psi}_{(+)}, \underbrace{\phi}_{(-)}, \underbrace{G_N}_{(-)}, \underbrace{G_T}_{(+)}, \underbrace{TB}_{(-)} \right) \quad (3)$$

16. Related to small sample issues is the "base year" problem. By construction, the SEA cannot reliably estimate the degree of RER misalignment in cases where the RER consistently diverged from the ERER during the entire time under consideration (Edwards, 1989). Thus the longer the sample period, the less likely this is an issue, as RER deviations from the ERER are rarely sustained over long periods.

17. For a detailed discussion about the theory behind the expected signs, we refer to Edwards (1989), Montiel (1999), or Schröder (2013).

In this equation, $T B$ refers to the trade balance, which depends on exogenous foreign aid flows (grants and loans made on concessional terms). The flow specification is thus typically used for foreign aid receiving low-income countries.

A priori, using either approach seems sensible in the Papua New Guinean context. The flow specification fits well given that the World Bank classifies PNG as a low middle income country and that foreign aid has historically comprised a significant proportion in PNG's budget. Moreover, it can be argued that PNG faces a binding credit ceiling as the nation so far has failed to place bonds in international fixed income markets. However, as PNG has done in the past, current account deficits can also be financed through foreign direct investment (FDI), particularly aimed at extracting natural resources, or bank loans. The stock-flow approach in Eq. 2 has thus also merit. In any case, rather than imposing potentially restrictive assumptions, our approach will be to "let the data select" the appropriate specification.

The SEA follows a three-step procedure. The first estimates the long-run relationship between the RER and fundamentals. That is,

$$\ln RER_t = \beta' X_t + \vartheta_t \quad (4)$$

where X contains a constant and the five macroeconomic fundamentals as outlined. Vector β includes the long-run parameters. The error term, ϑ , is assumed to be stationary with a zero mean.

The second step involves deriving sustainable values of the long-run fundamentals on the basis of which we compute the ERER:

$$\ln ERER_t = \beta' X_t^{Sust} \quad (5)$$

Here, X^{Sust} indicates the fundamentals at sustainable values. Step three calculates the degree of misalignment in the RER:

$$RERMIS_t = \frac{RER_t - ERER_t}{RER_t} \quad (6)$$

where negative (positive) values denote RER undervaluation (overvaluation).

4. Data and Estimation Method

A serious complication in the process of estimating RER misalignment is the lack of readily available data on the actual RER and many of the macroeconomic fundamentals. As for the RER, there are no price indexes on the prices of tradables and nontradables (Hinkle & Nsengiyumva, 1999). We use the IMF's RER proxy which is available on the International Financial Statistics (IFS) database. The IMF approximates the price index of nontradables, PNT , with the domestic Consumer Price Index (CPI). The price index for tradables, PTR , is proxied through the CPIs of the largest trading partners using geometric averages, where the weights are based on total trade shares. The multilateral nominal exchange rate, E , is constructed using the same weights. The resulting RER index is available over 1980-2016, which constitutes the sample period.

Similarly, there are no data on government expenditure on tradables and nontradables. To circumvent this problem, we impose an equality restriction on the parameters attached to GN and GT in the RER equation. This allows us to include total government consumption (GC) instead. We obtain GC from the Penn World Table (PWT) 7.1. As the PWT ends in 2010, we take the missing values from the Quarterly Economic Bulletin (QEB) Statistical Tables (Table 7.1, "recurrent expenditure") published by the BPNG. Following Baffes et al. (1999), productivity differentials (PROD), or the Balassa-Samuelson effect, we proxy with the ratio of PNG's GDP per capita (at current prices) to the unweighted average of GDP per capita of PNG's main trading partners.

There is also no direct measure for a country's trade policy (OPEN). We rely on the most widely used proxy, which is the trade ratio (exports plus imports divided by GDP). The premise is that, all else equal, countries with more liberal trade policies will exchange more goods and services with the rest of the world. We source this variable from the World Development Indicators (WDI). For observations on the NFA, we make use of the External Wealth of Nations II database of Lane and Milesi-Ferretti (2007). An issue is that the time series

Table 1 DF-GSL unit root tests.

Variable	<i>t</i> -Statistic	Model
ln RER	-1.2	Intercept
ln TOT	-1.5	Intercept & Trend
OPEN	-2.5**	Intercept
ln Prod	-2.2	Intercept & Trend
GC	-2.6	Intercept & Trend
NFA	-1.8	Intercept & Trend
TB	-2.8	Intercept & Trend

Notes: The null hypothesis is that the series under study contains a unit root. ***, **, *, denote the level of statistical significance at 1%, 5%, and 10%.

ends in 2011. The missing values for the years 2012-2016 we update assuming that in any year t : $\Delta NFA_t = CA_t$, where CA denotes the current account balance which we obtain from the WDI.¹⁸

For the terms of trade (TOT) we rely on various sources: the WDI, World Development Reports (WDR), and the Bank of Papua New Guinea (BPNG). We note that TOT is only available until 2015. Finally, the trade balance (TB) we also obtain from the WDI.

As for the estimation method, we first determine the stationarity features of the data. To this end we rely on the DF-GLS test due to Elliott et al. (1996) who show that their procedure has higher power than the conventional Augmented Dickey-Fuller (ADF) test. Table 1 reports the test results. They suggest that all variables are integrated of order one, $I(1)$, except OPEN for which we reject the null that the series contains a unit root at the 5% level. We thus treat the variables under consideration as a mixture of $I(0)$ and $I(1)$.

The next step involves estimating the long-run relationship between the RER and the fundamentals, that is vector β in Eq. 4. We adopt the fully-modified ordinary least squares

(FMOLS) estimator developed by Phillips and Hansen (1990). FMOLS is suitable when the sample size is small and there is a mixture of $I(0)$ and $I(1)$ regressors as in the present case (Phillips & Hansen, 1990; Phillips, 1995). FMOLS estimates are superconsistent. The FM procedure uses a semi-parametric approach to correct the bias in the OLS estimates arising from long-run endogeneities and serial correlation in the regressors.

Since economic policy reforms or any exogenous shock (e.g. the recent drought) may shift the relationship between the RER and fundamentals, we test for parameter stability using Hansen's (1992) Lc test, which is built on the FMOLS estimation method. We employ the same procedure to test for cointegration. Hansen (1992) shows that the null of parameter constancy of the Lc test statistic is equivalent to the null of cointegration among the variables under study.

Finally, there are several methods to derive sustainable values of the long-run fundamentals. The prime objective of any approach is to properly smooth out exogenous shocks. That is, the data series need to be decomposed into transitory and permanent components, where the latter is considered "sustainable" in the sense of Nurkse's (1945) ERER definition. One standard way to remove cyclical variations is to use a five-year moving average (Edwards, 1989; Elbadawi, 1994). However, PNG's economy has faced several unusually persistent and severe shocks in recent years. Therefore, a five-year average is not the appropriate tool to obtain the permanent components of the fundamentals here. This is particularly true for OPEN which is proxied through the trade ratio. The severe drought and continued foreign exchange rationing adversely impacted on both imports and exports in 2015/16.^{19 20} Applying a five-year average does not sufficiently smooth out such severe shocks. For example, the 2016 five-year moving average of the trade ratio would suggest that the trade regime has become

18. Empirically, the evolution of the NFA is also governed by "valuation effects" (VAL), which arise from movements in exchange rates or asset returns. That is, $\Delta NFA_t = CA_t + VAL_t$. Empirically, valuation effects are unobserved, serially uncorrelated, and of mean zero (Devereux & Sutherland, 2010; Schröder, 2015). Thus, the best forecast is $E_t(VAL_{t+1}) = 0$. Nonetheless, we acknowledge that NFA might be measured with error in the last years of the sample.

19. In 2016 the trade ratio was almost 50% lower than it was in 2010.

20. The trade ratio is thus an imperfect proxy for PNG's trade openness. There are, however, no other readily available measures of trade policy in the PNG context.

Table 2 The long-run relationship between RER and fundamentals

Regressor	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln TOT	0.09 (0.01)***	0.09 (0.01)***	0.13 (0.05)**		0.10 (0.01)***	0.70 (0.10)***	0.09 (0.01)***	
OPEN	-0.20 (0.05)***	-0.14 (0.02)***	-0.62 (0.08)***	-0.36 (0.08)***		6.65 (0.48)***	-0.16 (0.04)***	-0.64 (0.12)***
ln PROD	0.30 (0.03)***	0.33 (0.02)***		0.24 (0.05)***	0.38 (0.020)***	2.49 (0.26)***	0.31 (0.03)***	
GC	0.87 (0.19)***	0.71 (0.11)***	1.75 (0.44)***	0.73 (0.35)**	0.44 (0.19)**		0.86 (0.20)***	
NFA	0.02 (0.03)		0.16 (0.06)***	0.15 (0.05)**	-0.06 (0.02)***	-2.39 (0.20)***		
TB							0.02 (0.06)	-0.64 (0.19)***
Trend			-0.007 (0.004)*					
Constant	5.13 (0.11)***	5.17 (0.06)***	4.49 (0.23)***	5.68 (0.15)***	5.14 (0.12)***		5.10 (0.10)***	5.34 (0.13)***
adj R^2	0.96	0.95	0.85	0.90	0.94		0.95	0.70
L_c	0.57	0.41	0.48	0.27	0.48	13.9***	0.45	0.33

Notes: ***, **, * denote the level of statistical significance at 1%, 5%, and 10%. The dependent variable is ln RER. Sample period: 1980-2016. When TOT is included the sample period ends in 2015. Standard errors in parentheses. L_c refers to the test statistic for parameter stability and cointegration due to Hansen (1992). OPEN, GC, NFA, and TB are measured as a ratio of GDP. PROD is the ratio of PNG's GDP per capita to the average GDP per capita of the main trading partner

much more restrictive, even though this is not the case. Similarly, TOT has reached unprecedented high levels during the recent resource boom (see Figure 1), which reinforces the previous argument against using a five-year moving average.

We also abstain from applying the Hodrick-Prescott (HP) filter (Hodrick & Prescott, 1997), the most widely used decomposition technique, as the method is susceptible to generating spurious trends and cycles in the presence of stochastic trends (Cogley & Nason, 1995). Moreover, the HP-filter is well-known to perform poorly at the end of the sample, which is the key period of interest. Given these circumstances, we use ten-year moving averages to compute the sustainable values of the ERES fundamentals.²¹ This means that the RER misalignment estimates will be available from 1990 to 2016.

5. Results

Table 2 presents the estimation results of PNG's long-run RER behavior. Column 1 reports the result for the full specification, which includes all five fundamentals (cf. Eq. 2) in the model. The results suggest that increases in government consumption, productivity gains, and improvements in both the terms of trade and the net foreign asset position lead to an ERES appreciation. Conversely, the negative coefficient on OPEN implies that the ERES depreciates as the country becomes more open to trade. The variables thus enter the regression with the signs predicted by theory. However, the coefficient attached to NFA is not significant at conventional levels so that we subsequently drop this variable from the model. Column 2 reports the result. All coefficients are of the expected signs and statistically significant at the 1% level. In addition, the L_c test suggests that the estimated parameters are stable over the sample period and that the variables are cointegrated. In principle, we could now proceed with the next step in the process.

21. Since TOT is only available until 2015, the ten-year moving average uses only past terms.

However, an issue is that in addition to the specification of Column 2, it is possible to find many other subsets of the fundamentals that build a long-run relationship with the RER. While theory provides little guidance of how to deal with this, one well-established solution to this problem is to choose the most inclusive specification conditional on evidence of cointegration, stable and significant coefficients, and parameter signs that align with theoretical priors (Montiel, 2007; Schröder, 2013; Schröder, 2017b).

Columns 3-6 report the results for the specifications which include four of the five fundamentals, respectively. Based on our selection algorithm, we disregard the model reported in Column 6 since the sign of the coefficient attached to OPEN is of the opposite expected sign and we reject the null of parameter stability at the 1% level. This leaves us to choose one of the specifications in Columns 2-5 as any one of them satisfies the above requirements. Montiel (2007) advocates for selecting the model that yields the highest adjusted R^2 . Here, this is the one in Column 2 ($\bar{R}^2 = 0.95$).

However, we have reservations to proceed with this specification. As discussed, PROD uses nominal GDP per capita figures to proxy for productivity differentials in the tradable sector. While this proxy works well in most cases (Baffes et al., 1999; Schröder, 2013), it suffers from weaknesses in the case of PNG. Up until recently, "overall" GDP and "non-resource" GDP moved hand-in-hand, but since the commencement of the PNG LNG project in 2014, there has been a significant divergence between the two series in the sense that overall GDP grew by 15% in 2014/15, whereas there was virtually no growth in non-mining GDP during the same period.²²

The non-resource part of GDP is much better suited to capture the theoretical counterpart of productivity growth in the tradable sector in developing countries.²³ This is so because, while

mining/LNG form part of the tradable sector, resource-based activities in developing countries are highly capital and skill-intensive so that these countries need to import technology and labor. Thus an increase in overall GDP solely due to natural resource extraction has little to do with actual productivity improvements. This means that relying on overall GDP to proxy for productivity gains is likely to underestimate the level of RER overvaluation, especially for 2014-2016, the main years of interest.²⁴

In light of the above discussion, we prefer the specification in Column 3 since it does not include PROD. The estimation results suggest the following long-run RER behavior. All else equal, a 10% improvement in the terms of trade leads to an appreciation in the ERER of about 1.3%. Increased trade openness depreciates the RER in the long run. In particular, the semi-elasticity of -0.62 suggests that every 1 percentage point increase in the trade ratio depreciates the ERER by 0.62%, *ceteris paribus*. Moreover, a 1 percentage point reduction in the ratio of government consumption to GDP is expected to depreciate the RER by 1.75%, holding all the other fundamentals constant. Finally, the ERER appreciates by about 0.16% for every 1 percentage point improvement in the net external position (measured in terms of GDP). Overall, these estimates are encouraging as they are in line with economic theory. In terms of magnitudes, the ERER seems to be particularly responsive to changes in government consumption and, perhaps surprisingly, relatively unresponsive to movements in the terms of trade. Nonetheless, all of the above point estimates fall within empirical bounds.²⁵

Finally, we note that we also experimented with the flow-approach as laid out in Eq. 3. The result for the full specification is reported in Column 7. While the coefficients on TOT, GC, OPEN, and PROD are significant and bear signs consistent with economic theory, the one

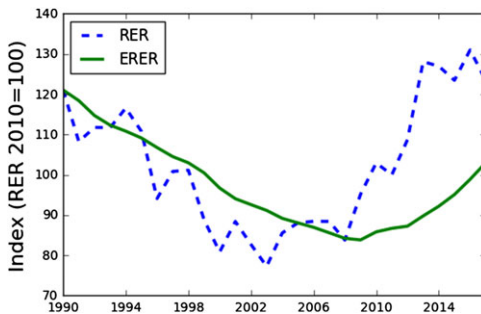
22. Paul Flanagan (27 October, 2015), "PNG Growth -- The Measurement Challenge", <http://pngconomics.org/?pageid=36>, September 15.

23. Using non-resource GDP as a proxy for productivity gains in the tradable sector is not possible as the PNG Treasury only began publishing this series from 1998 onwards.

24. Indeed, proceeding with this specification generates RER overvaluation estimates that are 5 percentage points lower than the ones of our preferred specification.

25. Cf. the results in Schröder (2013) who estimates RER misalignment for 63 developing economies over 1970-2007 on a country-by-country basis.

Figure 2 RER and EREER, 1990-2016. Note: An increase in RER denotes appreciation. Therefore, $RER > EREER$ indicates RER overvaluation.



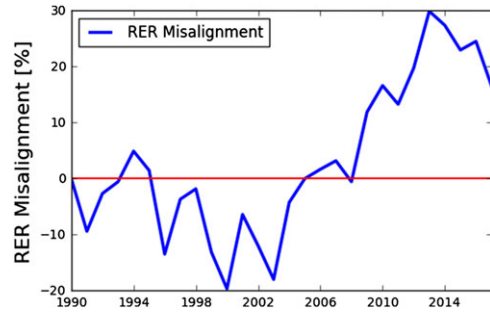
attached to TB is close to zero and insignificant. The most inclusive RER equation we find with TB included only comprises two of the fundamentals (Column 8). Given our selection algorithm, we conclude that the stock-flow setup (Column 3) is the more appropriate specification to explain the long-run movements in PNG's RER.

Figure 2 plots the EREER together with the RER over 1990-2016. Up until 1994, the EREER and RER did not significantly divert from each other implying that the degree of currency misalignment was small. As discussed earlier, this was the period of the second resource boom, which is characterized by macroeconomic stability and robust economic growth. After the boom, however, fiscal deficits and the external position became unsustainable so that the kina was devalued by 12% vis-à-vis the US dollar in September 1994. This nominal depreciation caused the RER to become significantly undervalued. In 1997 the Asian financial crisis and a severe drought adversely impacted on PNG's economy, which resulted in another nominal exchange rate depreciation of 30% due to serious concerns about the country's external position.²⁶ Real undervaluation continued for several more years before the RER adjusted back to its equilibrium level in 2004.

Turning to the main finding of the paper, an unprecedented resource boom was the catalyst

26. Here, the nominal exchange rate refers to kina per US dollar.

Figure 3 RER misalignment (%), 1990-2016. Note: Positive values indicate RER overvaluation.



for a precipitous RER appreciation from 2007 onwards. This translated into an ever-growing RER overvaluation that continues to the present day. Thus, our results suggest that the answer to the question posed in the title of this paper is an unambiguous "yes".

Figure 3 plots the degree of RER misalignment over the same period. Consistent with the discussion above, the RER was by and large aligned with its equilibrium value up until 1994, before entering a long phase of real undervaluation until 2004. The episode culminated in 1999 when the RER was undervalued by 20%. Since 2008, real overvaluation has been substantial, never below 12% and 30% at the highest level in 2012. Since then, the kina has depreciated at a slow pace, which lead to a mild reduction in the extent to which the RER is misaligned. Nonetheless the RER remained significantly overvalued at 24% in 2015. In 2016, the RER depreciated slightly, but remained overvalued by about 17%.

Due to lack of data, we are able to only make approximate projections for 2017. Since March 2016, the nominal exchange rate has remained fixed at about 3.17 kina per US dollar. Since there is also a positive expected inflation differential between PNG and its main trading partners (7.5% versus 1.5%), we anticipate an increase in the degree of RER overvaluation back to about 20-22% in 2017. The ongoing and ever increasing backlog in foreign exchange orders indeed suggests that a significant real depreciation will be needed to close the gap between the RER and EREER. Based on our estimates and projections, we

advocate for a kina depreciation in the neighborhood of 20%.

6. Conclusion

The purpose of this paper has been to estimate misalignment in PNG's RER. To this end we have relied on the single-equation approach which estimates the ERER in a three-step procedure. The first uncovered the long-run relationship between the RER and a set of macroeconomics fundamentals, the second derived the ERER, and the third computed the degree of RER misalignment. Our results suggest that the RER was overvalued by about 24% and 17% in 2015 and 2016, respectively. For 2017, we project that RER overvaluation increases slightly to 20–22% due to the now-fixed nominal exchange rate and the inflation differential between PNG and its trading partners.

Our findings have important policy implications. The BPNG should devalue the kina by about 20% in order to restore both internal and external balance. This could be done either through a one-off or gradual devaluation. In the medium run, BPNG may also consider moving towards a floating exchange rate system since it is likely to produce better outcomes than the heavily managed regime of the last few years. The benefit will be a better allocation of resources which will promote economic growth. The opposite will occur should the BPNG maintain an overvalued RER through foreign exchange controls. Moreover, the experience of many Latin American countries in the 1970s and 1980s suggests that such restrictions are ineffective in preserving international reserves and the exchange rate in the long run since black markets will develop eventually. Parallel markets entail additional economic costs as they encourage rent-seeking behavior, lower the government's tariff and seigniorage revenues, and divert export receipts from official channels (Agenor, 1992). Paradoxically, the last point implies that there will be a currency crisis as the central bank will eventually run out of reserves: an outcome the foreign exchange controls were supposed to prevent in the first place. It is in the hands of the central

bank to prevent such a costly and harmful outcome.

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